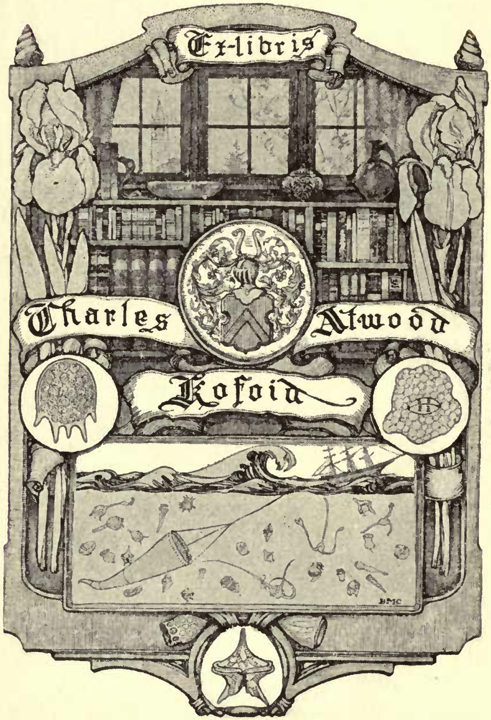
THE STORY OF THE BIRDS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THE STORY OF THE BIRDS

FROM ARCHÆOPTERYX TO BIRD OF PARADISE.

THE STORY OF THE BIRDS

BEING AN INTRODUCTION TO THE STUDY OF ORNITHOLOGY

BY

CHARLES DIXON

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"RURAL BIRD LIFE," "THE GAME BIRDS AND WILD FOWL OF THE BRITISH ISLANDS," "BRITISH SEA BIRDS," "CURIOSITIES OF BIRD LIFE," "THE MIGRATION OF BIRDS," "BIRD LIFE IN A SOUTHERN COUNTY," "AMONG THE BIRDS IN NORTHERN SHIRES," ETC. ETC. ETC.

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PREFACE

THERE are many people who take an intelligent interest in Birds and their Habits, and would like to acquire a more extended knowledge of ornithology were they not discouraged by the dry and technical manner in which such information is usually conveyed. The present volume has been written with a view to removing some at least of these obstacles to the acquisition of a general knowledge of Birds. We have sought to tell their story simply and in language as free from technicalities as possible; to produce a guide or handbook to the study of birds that shall be both popular and accurate as we can make it. We make no pretensions to completeness or finality, for such could scarcely have been even approximately reached had each chapter been expanded into a volume; but we do claim for our work that no reader can master its contents without gaining a very general knowledge of the avine kingdom. Whilst always

endeavouring to make the Story popular we trust we have never done so at the expense of its philosophic importance.

The Story that the Birds have to tell us is indeed a fascinating one. Beginning with the Origin and Descent of Birds during geological epochs so remote that the mind fails to grasp or realise the mighty vastness of time that separates the Then from the Now, we pass on to a consideration of their salient characteristics in existing forms, their anatomical features, the bony framework and internal organs, the peculiarities of their dermal covering, its structure, colours, and functions. Then we take up the subject of the various Groups or Orders into which systematists have divided Birds, the composition of those orders, the affinities and peculiarities of the species in them. After which we trace out the Distribution of Birds over the earth, and then endeavour to ascertain the conditions of their Dispersal and the laws that govern their Migrations. Then comes the subject of the General Habits and Functions of Birds—their Flight, terrestrial and aquatic motions, Social Instincts, Food, and the many methods of obtaining it, the Mimicry of Birds, their Protective Colouration and Resemblances, Variation and

Dimorphism. Our next stage in their Story brings us to their marvellous methods of Courtship, their Love Displays, their bridal Songs and Cries and Sounds. This is fittingly succeeded by a scientific study of their Nests and Eggs, which brings their Story to a close.

CHARLES DIXON.

PAIGNTON, S. DEVON.

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THE STORY OF THE BIRDS

CHAPTER I

THEIR ORIGIN AND SALIENT CHARACTERISTICS

Diagnosis of a bird—Descent of birds—Archæopteryx—Cretaceous Ornitholites—Upper Eocene Ornitholites—Miocene Ornitholites—Pliocene Ornitholites—Tertiary gigantic birds—New Zealand Moas—Madagascar Æpyornithes — Miocene tropical genera in Europe — The feathers of birds—Contour feathers—Down-plumes—Powder-downs—Filoplumes—Colour of feathers—Abnormal colouration — Arrangement and pattern of colour — Differences in colour due to age, sex, and season — Colour and environment — Moulting — The avine skeleton—The anterior and posterior limbs—The head or skull—Internal organs—Muscular, nervous, and digestive systems — Respiratory organs — The young of birds.

"WHAT is a man?" asks Galatea of Pygmalion in Mr. Gilbert's famous play. "What is a bird?" the curious reader may ask, and possibly ask ninety-nine people out of every hundred without obtaining any satisfactory definition of such a well-known and familiar creature. Birds are familiar to all of us. To almost every kind

of scene they impart an ever-welcome sense of life; whilst of all organisms they are as a class the most beautiful, the most tuneful, and we may even add the most widely and generally interesting. The old proverb that "A bird is known by its feathers" amounts to a strictly scientific diagnosis of the class Aves, for feathers are otherwise unknown in the animal kingdom, and therefore become the most important characteristic of a bird. There can be no reasonable doubt that birds are more closely related to reptiles than to any other class of animal life. The close propinquity of the two classes—reptiles and birds—was unreservedly recognised by Huxley, that great comparative anatomist associating both under the term Sauropsida, the two combined forming one of the three primary groups into which he divided vertebrated animals.

It might reasonably be thought that as birds are so obviously closely related to reptiles, the descendants in fact of one common ancestor from which both classes of organisms (Reptilia and Aves) have sprung, there would be definite evidence in existence, in a fossil form, to indicate the line of their descent. But although we may be practically certain that birds and

reptiles are more closely related to each other than either is to all remaining forms of vertebrate life, nothing displaying nearer affinities with birds than those gigantic reptilian forms known as Dinosaurs have yet been discovered. Casts of footprints found upon the Triassic sandstone in the valley of the Connecticut in New England were long supposed to be those of birds, but palæontologists appear now to be generally agreed that these impressions were made by the feet of Dinosaurian reptiles. Some of these footprints, measuring as many as seventeen inches in length, indicate creatures of vast size with a stride of about eight feet! Dr. Hitchcock enumerates the footprints of as many as twenty-three species of what he termed Ornithichnites —a Greek compound, signifying fossil footprints of birds, and which of course in the light of modern opinion now becomes obsolete. From the Bunter Sandstein of the Triassic system to the Solenhofen slate formation of the Jurassic system constitutes a vast period of geological time, and yet this separates these reputed Ornithichnites from the first really fossil bird respecting the identity of which authorities are in no doubt. This, the earliest known avine form, is the Archæopteryx (a second species has lately

been described from the same locality), a creature which, although presenting not a few reptilian characteristics, was unquestionably during life a feather-clad bird. The Archæopteryx was a bird about the size of a Crow, with a short blunt bill. The upper jaw was furnished with thirteen and the lower jaw with three conical teeth on each side, each embedded in a distinct socket. This curious bird was also furnished with a long lizard-like tail composed of twenty-one vertebræ, from each of the first twelve of which grew a pair of feathers. The three free digits of the wing were armed with claws. Of course nothing can be said with certainty respecting the habits and mode of life of the Archæopteryx, but the structure of the feet suggest a possible arboreal existence.

The next known bird forms (Ornitholites) appear in the Cretaceous epoch. All these, so far as is known, still continue to present the character of teeth, but the lizard-like tail completely disappears. Many of the remains found in the deposits of this epoch, and formerly believed to be Ornitholites, have been shown to be those of Pterodactyls (bat-like reptiles). However, in 1858, undoubted avine remains (of a form believed by some authorities to be allied

to the modern Divers) were discovered by Barrett in the Upper Greensand of Cambridgeshire; others obtained from the chalk formation of South Sweden have been described by Professor Dames. A much more extensive series of Ornitholites (referable to no less than seven genera) from the Cretaceous rocks of North America have been described by Professor Marsh. Two of these, from the shales of Kansas, formed his distinct sub-class Odontornithes, but as all Cretaceous birds are believed to have been toothed the term has more recently been employed to embrace all Ornitholites of that epoch. The list of Pre-Tertiary Ornitholites is comparatively a small one. As might naturally be inferred Ornitholites become much more numerous in Tertiary deposits. Avine evolution must have been progressing upon a vast scale during the closing ages of the Cretaceous and the early eras of the Tertiary systems; and not only do we find a much greater and most significant wealth of avine fossils, but a steady progress towards those types which dwell upon the earth in our own time, or which occupied it in ages not very remotely preceding the present. Some of the most remarkable Ornitholites of the early Tertiary Period relate to

such gigantic avine forms as Gastornis. Fossil remains of this bird have been discovered in the south of England (near Croydon), as well as on the Continent. Specialists are by no means agreed respecting its affinities, but its large size is indisputable, bigger than an Ostrich, and like that bird incapable of flight. Another remarkable Ornitholite belonging to this era of strange avine forms is the Odontopteryx toliapica from the London Clay of Sheppey, representing the remains of a bird possessing curiously serrated jaws. At this era appear the remains of Halcyornis (also from the Sheppey beds), considered by some to be allied to the Gulls; of Proherodius, showing affinities with the Herons; and Lithornis, provisionally associated by Owen with the Birds of Prey, but possibly more nearly allied to the Cranes. Osteornis from the shale of Plattenberg at Glarus may belong to the present wide-ranging and dominant order of the Passeres.

Passing on to the Ornitholites of the Upper Eocene we have the remarkable series of avine remains from the Paris Basin, with the identification and comparison of which the names of Cuvier and Milne-Edwards are so inseparably associated. Of the fourteen genera to which

Milne-Edwards referred the various remains no less than half are still existent, whilst the other seven are more or less closely allied to others in a similar state. Precisely the same remarks apply to the Ornitholites of this period from equivalent beds in other parts of Europe, including our own islands, but the remains of many additional species have been discovered, most of them more or less distantly allied with types that are living in our own era, although in not a few cases not in the same geographical areas as was then the case. The Ornitholites of North America tell a very similar story; whilst a most interesting avine fossil of this period from New Žealand, Palæeudyptes antarcticus, a giant Penguin standing seven feet high, is specially worthy of mention.

The Ornitholites peculiar to the Miocene Period, as might naturally be expected, still continue to present, and in increasing abundance, characters which indicate still closer affinities with genera and species of birds that are in existence now. Some of course of those fossils represent types that have completely disappeared from the earth, but in few cases do we find such vast distinctions that characterise the Ornitholites of earlier eras, an eloquent and

most significant demonstration of the wonderful progress of avine evolution. Two of the most remarkable types of this era are Phororhacos and Brontornis. These avine giants are from the Miocene deposits of South America. These, together with several other genera (in all we believe eight or nine are recognised), comprise what shortly after their discovery was supposed to be an absolutely new order of birds to which the name Stereornithes was applied, but which subsequently was declared to possess no such taxonomic importance. These very wonderful bird remains, the existence of which was only discovered a decade ago, appear to indicate a rich avifauna in South America even at that remote era, and form evidence of a most significant kind relating to the dispersal of life over the globe. The most remarkable feature of these birds is the enormous size and massive structure of the head, in comparison with the limbs, although some of these are of gigantic proportions. Probably we never shall have any but the faintest idea of what these bird monsters were actually like in life, but that they must have presented a most impressive appearance with their huge laterally compressed and hooked beak, cannot be doubted. That

they were unable to fly seems certain. Some Ornitholites of this era found in Europe are intermediate between the Storks and Ibises (Ibidopodia), another a species allied to the Flamingoes (Palælodus). We must attribute the comparative scarcity of Ornitholites in the Pliocene deposits either to the prevailing conditions at that time being unsuitable for their effectual preservation or to our own want of success in discovering them. The fragments of the Pliocene avifauna so far as they have been revealed by scientific investigation represent the remains of birds differing little from types existing to-day, whilst many of them were undoubtedly generically and in some cases possibly specifically the same. A significantly still greater similarity characterises the avine remains of the Post-Tertiary Period; whilst the geographical area occupied by these Pleistocene birds is in most cases the same as that of their surviving representatives or descendants. In the majority of instances these Post-Tertiary relics are, so far as we can judge, of the same species that exist to-day. Some of course have become extinct altogether, as for instance the Crane (Grus primigenia) and the Pelican, remains of which latter have been

discovered in the English Fens; others have disappeared from scenes which their remains tell us they once occupied; as for instance the Snowy Owl and the Capercailzie from Devonshire, bones of which have been found in that wonderful necropolis of our ancient fauna, Kent's cavern, near Torquay.

Two other points seem specially worthy of a brief notice before we leave this portion of the subject. The first relates to the gigantic birds of the early Tertiary Period. There can be no doubt that some at least of these ponderous avine types managed to survive in one or two favourable spots until quite recent times and long after their contemporaries had vanished from the earth. The two most famous sanctuaries of these archaic birds are the long and completely isolated areas of New Zealand and Madagascar. Among these curious birds, remains of which have been discovered in quite recent deposits (notably near ancient camping places of the aborigines, in caves, sand drifts and swamps) in New Zealand, may be mentioned the Moas (Dinornis), the huge Raptorial bird Harpagornis, and a monster Goose. All these birds were flightless. It is round the Moas that most interest gathers, not only

because their remains have been carefully studied by Owen and others, but their previous existence lingers in the traditions of the Maori people themselves, a race now almost as extinct as the huge birds with which it was contemporaneous. Taking into account the comparatively restricted area to which they were confined, these birds must have been not only numerous in species but in individuals; whether these giant birds attained such a development in such narrow geographical limits is yet a moot question. Moas were either destitute of wings or possessed them in a rudimentary or functionless condition only. This helplessness unquestionably contributed to their rapid extermination when savage man appeared upon the scene. How long they lingered we have no reliable means of ascertaining, although Hutton considered that they became extinct between 300 and 500 years ago.

Of little less interest are the extinct Æpyornithes of Madagascar, perhaps chiefly because they are generally believed to be the Rocs of Arabian romance. If this be so it shows how even the wildest fable may rest upon a more or less complete foundation of fact. Even to this day some of the inhabitants of that African

island cherish the belief that these birds still exist, and attribute to them (which of course is fable pure and simple) the power of flight. The first definite indication that such huge birds had formerly lived in Madagascar was the discovery of their colossal egg-shells, supplemented afterwards by the finding of bones. These remains have been referred to no less than five species, some however of which belong to birds of much smaller size. One of these large egg-shells is now in the British Museum, and measures some thirteen inches in length by nine and a half inches in breadth; whilst a still larger example was formerly in the possession of the late Dawson Rowley. The flightless and consequently helpless condition of these stupendous birds must soon have led to their complete extermination after man appeared in the island.

The second point to which I specially want to refer is the occurrence in the Miocene deposits of Europe of certain genera of birds that in our time are strictly confined to the Tropics. Among the most remarkable of these may be mentioned the remains of Psittacus (a genus of Parrots), a form of Swift (Collocalia) now confined to the Tropics, a Secretary Bird (Serpentarius), what appears to have been a

Hornbill, a Plantain-eater (Necrornis), an Adjutant (Leptoptilus), certain forms of Cuckoo (Centropus), and Trogons (Trogonidæ). By most zoologists the presence of such species in Europe is taken as an indication that the climate at that time was much warmer than it is now, or even of a tropical character. This may or may not have been the case; but to suggest that these birds (now only found in warm latitudes) were driven south by the cooler climate of the succeeding Pliocene era, or the intense cold that characterised that of the Glacial Epoch, is not, in my opinion, a correct interpretation of the facts. I maintain that one of the laws of dispersal is that species never retreat from adverse conditions of life. All such species that during later Tertiary time had spread north and east from southern and even equatorial bases, and become sedentary in the warm equable climate of Euro-Asia must have been completely exterminated by the advent of adverse conditions of life, primarily due to a change of climate. Let it then be clearly understood that these avine types now extinct in Europe did not originate there during the long-continued warm climatic conditions of the later Tertiary Period, that they did not at the approach of a cooler

climate retreat southwards towards the Tropics, but that they originally extended their range northwards from southern bases where the generic roots of such forms exist to-day, notwithstanding the fact that a glacial catastrophe exterminated all these northern offshoots of which a few scattered relics have been discovered.

The lesson then briefly summarised that all Ornitholites convey is that existing birds—birds as we see and know them to-day, have descended in a direct line from ancestors which differ more and more widely from living types the farther we trace them back into the remote past, until we are confronted by those semi-reptilian forms which appear to be the earliest progenitors of the great and now highly specialised avine group.

Having thus briefly glanced at the origin of birds let us pass on to a consideration of the most salient points in the structure and characteristics of existing forms. Commencing with external features, a bird, as we have already stated, is known by its feathers. What are feathers, those wondrous things with which all birds are clothed, the chief vehicle of their matchless beauty, the bearer of those glorious sheens and tints and hues that single out this

class of creatures as the most attractive of organic beings? Feathers, with the skin in which they grow, form the integument of a bird, and are classed with hairs, bristles, metatarsal scales, spurs, claws, and bill sheaths as epidermal structures. Probably many readers may think that feathers grow from all parts of a bird's skin, but such is not the case (with almost the sole exception of the Penguins, Screamers, and Ratite birds such as Ostriches). The feathers of a bird grow in various tracts or well-defined patches, technically called pterylæ, the spaces between these tracts, whether covered with down or absolutely naked, being known as apteria. These feather tracts are known as the pterylosis or pterylographie of a bird, and as they vary a good deal in their pattern or direction in the several groups, their study is of some importance to the ornithologist in his efforts to form a natural classification of birds. Feathers not only grow upon the newly formed chick, but at certain intervals of time upon the adult bird, when they are renewed either to replace accidental loss, or at the seasons of the moult when the old plumes are shed or pushed out by an entirely new set. We may define feathers then as horny products of the epidermal cells of the

skin which collectively form the covering of a bird and enable it to fly. A feather, generally speaking, consists of the following parts: A, the barrel or quill, *calamus;* B, the principal shaft, *rhachis;* C, the secondary or aftershaft, *hypo-rhachis;* D, the web composed of a regularly arranged series of fibres or barbs, *rami*, attached to which are a double series of barbules or *radii*, which again in their turn give rise to barbicils or *cilia*, which latter generally end in hooklets, *hamuli*. These latter it should be remarked are of very great importance, because they serve to interlock or join the barbules and barbs together, and thus serve to render the surface of the flight feathers almost impervious to air. Feathers may be roughly divided into three classes; viz. contour feathers, down-plumes, and filoplumes. The first are not only the largest but perhaps the most important. They are those that appear nearest the surface, and therefore form the outline or contour of the bird's figure. They reach their greatest development of course in the wings (remiges) and tail (rectrices). In some of these feathers the cilia, and consequently the hamuli are wanting, thus forming the disconnected webs and decomposed plumes which are displayed as ornaments or decorative tufts in so many birds.

In other of these contour feathers the barbs are absent altogether, the rhachis being webless; as in the wing quills of the Cassowary, the rectrice wires of certain Birds of Paradise, and in most of the tail-feathers of the Lyre Bird; whilst the same remarks apply to the rictal or gape bristles with which so many birds are furnished, and the eyelashes of such birds that possess them, as the Hornbills. In some species the tip of the rhachis, as for instance in the neck hackles of certain Galline birds, and in some of the wing and tail feathers of the Waxwings, is expanded into wax-like modifications or processes. The down-plumes, as their name suggests, are softer in texture than the contour feathers by which they are hidden, are present in greater numbers, but are smaller. In these feathers the hooklets (hamuli) are wanting, and the rhachis or shaft is often absent, the barbs sprouting from a stunted calamus. In connection with this type of feather mention should be made of those highly curious down-plumes known technically as "powder-downs." They derive their name from the fact that the slender tuft-like barbs and barbules of which they are composed are continually dis-integrating or crumbling at the tips into fine powder. Powder-downs in some birds grow

over almost the entire body, not only on the bare places between the contour feather tracts but amongst these feathers themselves. In other birds they are confined to certain spots or are developed in well-defined pterylæ. These peculiar feather growths are by no means common to all birds, only appearing in certain groups. Some of the most notable of these are the Herons and Bitterns, the Parrots, the Tinamous, a few of the Birds of Prey (Blue-winged Kite, Harriers), the Frog-mouths (a group of Goatsuckers), and some of the Rollers. The archaic character of these powder-downs seems indicated by the fact that only in a single genus (Artamus) of the extensive and highly specialised group of Passeres are they known to occur. Lastly we have to notice that peculiar kind of feather which is known technically as a filoplume. A filoplume is composed of a short barrel (calamus) terminating in a slender hair-like shaft (rhachis), carrying few or no barbs (rami), and forms what is popularly termed an aftershaft, technically called an hyporhachis (already alluded to in describing the various parts of a feather). This filoplume starts from the base of the quill and varies a good deal in the degree of its development in the different avine groups. It becomes specially small in the

Passeres, almost absent in the Pigeons, Woodpeckers, Owls and so on, but is as large as the main rhachis in the Cassowary and the Emu. The aftershaft is generally concealed by the contour feathers, but in some cases it extends beyond them in the form of long slender filaments or hairs on the neck or back. The Blackbird furnishes a familiar example of a species possessing these nuchal hairs, whilst some of the Bulbuls in the genus Tricholestes may be cited as notable instances of the latter. Some of the Warblers and Finches also exhibit them; whilst the white thread-like filaments displayed by Cormorants are apparently another form of filoplume. It may be mentioned that the soft downy covering of so many young birds resembles the down-plumes of adults, although it differs in certain respects, notably in the abortive or even absent shaft, the absence of cilia, the filamentous rami, and with one exception the absence of an aftershaft. But these are details of far too technical a character to be dealt with in a work aiming above all things to be popular, and must be left to the more advanced student of birds.

Having thus briefly dealt with the distribution, structure, and growth of feathers, it now becomes

necessary briefly to glance at the colour with which they are adorned. This too is a most complicated subject, and one which we can only deal with here in a cursory way. In the first place, to what is the colour of a feather due? Colour is due either to pigment or to peculiarity of structure, or to both these causes combined. These three causes may be thus briefly summarised. In the first place colour may be produced by pigment, either in a diffused solution or in the form of pigmented corpuscles. Colours produced in such a way are constant in the sense of not varying in tint in whatever position the light may fall upon them or the eye may view them. These colour pigments are firstly black (Zoomelanin), secondly red (Zoonerythrin), thirdly yellow (Zooxanthin), and fourthly and fifthly peculiar pigments, red (Turacin) and green (Turacoverdin), only known to be present in the plumage of the Plantain-Eaters (Musophagidæ). Brown, it may be remarked, is a combination of black and red; white is not due to pigment, but the appearance of such a feather is due to the countless spaces between its molecules which diffract and reflect the light. The remarkable gloss, irrespective of colour, on so many feathers is due to their highly polished surface. In the

second place we have colour arising from a pigment in combination with the overlying colourless structures in the form of irregular longitudinal ridges or polygonal bodies, between the surface of the barbs and barbules and the pigment. When the polished surface of such feathers is scratched or held up against the light only the colour of the pigment is visible. This is the case with many blue, yellow, orange, and green feathers. In the third place we have those wonderful prismatic or metallic colours, of which the radiant Humming-Birds offer the most striking example. In these feathers a black or blackish-brown pigment rests below a transparent colourless layer, the surface of which may be either smooth and polished, covered with longitudinal ridges or sprinkled with innumerable pits, which serve as a series of prisms or facets, and change the colour of the feathers according to the direction from which the light falls upon them. It is interesting to know that these prismatic colours change their hue in the same order as those in the rainbow. When the light glides in a vertical direction over the surface of all these metallic feathers, the luminous rays are absorbed and they appear black. But, as Martin observes, respecting the plumage of Humming-

Birds, it is no longer the same when the light is reflected from these feathers, each of which performs the office of reflector. Then it is that the aspect of the emerald, the ruby and so on, varying with the utmost diversity under the incidences of the rays which strike them, is given out by the molecular arrangement of the barbules. It is thus that the gorget of many Humming-Birds takes all the hues of green, and then the brightest and most uniformly golden tints, down to intense velvet-black, or, on the contrary, that of ruby, which darts forth pencils of light, or passes from reddish orange to a crimson-red black.

A few words on abnormal colouration must conclude this portion of the subject. Possibly the most familiar form of Heterochrosis is Albinism. I dare say every reader can recall a partial or complete instance of such a form of abnormal colouration, say in the Blackbird or the Pheasant, to quote the most familiar species. This is due to the absence of black pigment. Perhaps the next most familiar form of exceptional colouration is that which is technically known as Melanism. This is exactly the reverse of albinism, and is caused by an excess of black pigment which renders the feathers abnormally

dark in colour. Less familiar forms of Heterochrosis are Xanthochroism and Erythrism, in which an abnormal amount of yellow or red pigment is present. In some cases at least (especially of the latter form) this is the result of exceptional food. Lastly, the arrangement and pattern of colour upon feathers demands a few words of explanation. These to a great extent are due to age, sex, or season. In many species spots and streaks are a sure indication of youth or immaturity, just as transverse bars, on the other hand, are characteristic of the adult stage of existence. In some highly specialised groups (as for instance the Crows) there is but little difference in colour between the nestling and its parent, but in other groups (as for instance the Gulls) several years may elapse before the young finally get rid of their characteristic dress of youth and assume the very different tints of the adult, during this period between youth and maturity practically recapitulating the ancestral changes the species has undergone, it may be from a mottled or spotted form to unsullied grey and white, as in the Gulls and Terns. In a great many birds the male is the most brilliantly coloured, and remarkable for those wonderful modifications of plumage that are classed

amongst secondary sexual characters. There are, however, one or two exceptions to this rule, the Phalaropes, the Dotterel, and certain Parrots furnishing us with instances in which the female is most brilliantly adorned. The colour of a bird's plumage in a great many instances varies considerably according to season, and in some cases great difference is produced by a long fringe of barbicels that conceal much of the conspicuous tints on the rest of the plumage, and which abrade and drop off as the breeding season approaches, but these matters are perhaps best dealt with when we come to consider the moulting of birds. Incidentally we may remark that the Snow-Bunting and the Brambling present us with two capital instances of this peculiarity. The correlation of colour with environment is another branch of this interesting subject. Most readers may recall how birds of white plumage usually live amongst snow-clad localities, as for instance the Snowy Owl and the Ptarmigan; how others that dwell in deserts and on sandy plains are clothed in plumage in which brown or yellow predominates; how so many forest-haunting species such as Parrots, Fruit Pigeons, Barbets, and so on, are of tints in which green largely prevails. These are in most

cases modifications of colour for purposes of concealment, whilst yet another branch of this fascinating subject of animal colouration deals with the curious phenomena of Mimicry (in birds the known instances are comparatively few) and with recognitory and warning colours. (Conf. *Curiosities of Bird-Life*, Chaps. vii. viii.)

We cannot well leave the interesting subject of plumage without devoting a few lines to the moulting of birds. Moulting is the changing or renewal at stated periods of the old abraded and worn feathers, these being shed and replaced by new ones. Every living bird is subject to this process at least once every year, a complete change of dress usually taking place shortly after the breeding season is over. In addition there are many birds that undergo a complete moult twice in the year, in spring and autumn; others which have a partial moult in spring as well as the full moult in autumn; whilst others, yet again, may almost be said to be in a chronic state of moult throughout the year. Birds with a double or partial spring moult undergo this just previous to the nuptial season, then acquiring those various wedding ornaments for which so many species are famous. So far as concerns the smaller contour

feathers moulting is a slow and gradual process, and as far as is known with little or no stated order of sequence, although I have remarked in not a few species that the feathers of the head are the last to be changed. The flight feathers of the wings, and those of the tail, are shed and renewed in pairs, in most cases, so that the bird shall not be inconvenienced or incapacitated from flight during the process. In some groups, however, especially in the Swans, Geese, and Ducks, the wing quills are shed rapidly and all, practically, at once, so that the birds cannot fly until the new feathers have grown. The Grebes, some of the Rails, and the Flamingo furnish others. During this period of comparative helplessness the birds skulk amongst dense cover, or repair to the sea or other open expanses of water, whilst the males of many species of Ducks discard their showy plumage at this time, acquiring a dress very similar in colour to the female, which they wear for some weeks until able to fly again. Incidentally we may remark that one species, the Logger-headed Duck, Tachyeres cinereus of Patagonia, never seems to regain the power of flight after the first moult of its wing quills. Young birds, generally speaking,

are later in their moult than adults, and in a great many cases the first set of quills are retained during the first year of existence, although in not a few Gallinaceous birds, which are able to fly before fully grown, new sets of quills are acquired as maturity is reached. Among birds that moult very slowly, or that are in a chronic state of plumal change, may be mentioned the Swifts, the Birds of Prey, the Herons, and the Ptarmigan. With the exception of the latter, which by the way dons no less than three distinct plumages in the year, all these birds appear to be moulting their wing quills very slowly throughout the year save perhaps in the breeding season. Some of this change of colour, due to season, is produced by an actual change of pigment and not by a replacement of the feather. (Conf. *Stray Feathers*, p. 154, for additional details respecting the moulting of birds.) Before leaving this portion of the subject we may briefly allude to another periodical change which takes place in the integument of certain birds. This relates to the peeling or shedding of the claws in some of the Grouse during spring, the elongation of the bill in the Redpoles during summer (possibly due to a change of food), the shedding of a horny projection from

the ridge of the bill (assumed by both sexes during the breeding season), by the American White Pelican, this peculiar excrescence strewing the breeding ground of these birds literally in bushels; and lastly the curious annual moult which the bills of some of the Auks undergo as well as the acquisition and shedding of the horny or fleshy growths above the eyes and round the gape. Our own familiar Puffin furnishes a most interesting instance of this phenomenon. Some very interesting details of this peculiar form of moulting amongst the Alcidæ are published by Dr. Stejneger in Bulletin No. 29 of the United States National Museum.

We will now proceed to a brief consideration of the most salient characteristics of the skeleton and internal structure of birds. Of course in a work of the present scope it is not only impossible but unnecessary to enter into any great detail of avine anatomy. The student must seek such information in special works, one of the most useful being Professor Newton's *Dictionary of Birds*, Dr. Gadow's contributions to which upon this subject being singularly full and original. To these contributions we are largely indebted for the following particulars

relating to the osteology and digestive system of birds. The skeleton of a bird may very naturally be divided into three principal parts, comprising the head, the trunk, and the limbs. The vertebral column not only contains and serves as a protection to the spinal cord, but supports the head and limbs. It is composed of a very variable number of units or vertebræ, which are divided according to the position they occupy into the following classes, viz., cervical relating to the neck, dorsal to the back, sacral or pelvic to the loins, and caudal to the tail. The first cervical vertebra is termed the Atlas, because it bears the head, and which is articulated with it by a single occipital condyle. The second, termed the Axis, because it is the pivot on which the atlas and head turn, is considerably longer and larger than the succeeding cervical vertebræ, remarkable for their paired or single ventral processes and vertical knobs, when in the former condition assisting to protect certain blood-vessels, and when in the latter serving for the attachment of the powerful muscles which work the flexible neck. Succeeding these come the dorsal vertebræ, which not only in many cases coalesce with each other, but always do so with the sacral or pelvic

vertebræ, and nearly always with the terminal portion of the caudal vertebræ which, fused together, form the Pygostyle or terminal triangular plate in which the rectrices or tail-feathers are carried. A typical avine vertebra consists of the centrum, an arch, and two ribs. The arch as already stated encloses and protects the spinal cord. This type of vertebræ, with the facets or articular surfaces saddle-shaped, is termed heterocœlous, and is restricted to Birds. The ribs of a bird are attached to the vertebræ firstly by a capitulum or head, and secondly by a knob or tuberculum. That portion next to the head is termed the neck, and this is succeeded by the shaft, composed of two pieces, the dorsal and the ventral. To the posterior margin of the dorsal section is generally attached a thin bony blade termed the uncinate process. This process is attached to the ribs (with the exception of the last) of all birds (save the Screamer), and is also present in some reptiles. When the ventral section reaches and articulates with the sternum, the rib is a "true" one; but if the sternum is not reached it becomes a "false" rib. Ribs according to their position are classified as follows: cervical, cervico-dorsal, thoracic, and lumbar. The number in these

various classes varies considerably, not only amongst species but even in individuals—a fact which renders them of no value from a taxonomic point of view. We now come to a consideration of that part of the skeleton technically called the sternum, or in more familiar language the breast-bone. This very important part of the avine frame is joined to the vertebral column, as we have already seen, by the thoracic ribs, whilst its anterior margin supports the coracoids, or strong bones connecting it with the scapulæ or shoulder-blades and the clavicles or collar-bones, the three pairs of bones combined forming the Pectoral Arch or shoulder girdle. The last-named are generally united or fused at the ventral end, into a V-shaped Furcula, much better known as the "wish-bone" or "merry-thought." The furcula is subject to considerable modification in certain birds, notably in the Crane, the Swan, and the Frigate Bird; in other birds the clavicles are degenerated, the dorsal portion alone being retained, the ventral end being reduced to a ligament. In some birds (the Parrots for instance) the clavicles are absent. In many instances the furcula is ossified with the anterior portion of the keel of the sternum; whilst in

Ratite Birds, the Frigate Bird, and the now extinct Dodo the coracoids and the shoulder-blades are fused together. Two very distinct types of sternum exist. Of these by far the most generally prevailing is that in which the ventral surface is provided with a ridge or keel (carina). The other type of sternum is that in which the keel is absent, more resembling a flat-bottomed boat (ratis). This latter is found in a few archaic types only, such as the Ostrich, Rhea, Cassowary, Emu, and Kiwi. Birds with a keel to the sternum are therefore termed Carinate Birds, whilst those in which this ridge is absent are called Ratita Birds, these groups forming the two divisions into which all living birds are separated by systematists. Before leaving the sternum we have to allude to the various processes on the sides behind the articulation of the ribs. The most noticeable of these are situated near the posterior portion, and consist of outgrowths (although connected by membranaceous tissue), giving the margin when macerated a more or less deeply notched appearance, or when the extremities are joined or enclosed by bone or cartilage they form what are technically termed fenestræ. In some birds two of these notches on each side of

the posterior margin of the sternum occur, in others but one. These peculiarities appear to possess little taxonomic value, the configuration of the anterior portion of the sternum being more important in this respect. The next portion of a bird's skeleton that we have to consider is the pelvis, composed of a number of fused vertebræ together with three bones on either side, the largest and most dorsal of which is called the Ilium, the ventral or middle one termed the Ischium, and the anterior and most slender of all known as the Os pubis, and all meeting at the acetabulum or cup of the pelvis in which the head of the femur or thigh-bone articulates. These three paired bones coalesce with each other at an early stage of the bird's existence, whilst the notch between the two first named of these bones becomes a foramen in all known birds with the exception of the archaic Ratitæ and Crypturi. From the trunk of the skeleton we now pass to a brief notice of the bones of the limbs. We will take those of the wings or anterior limbs first. These consist of the Humerus or upper arm-bone which articulates with the coracoid and scapula, the Ulna and Radius which together compose the forearm, and the Carpus or wrist,

the Metacarpus or space between the wrist and the digits, and the Digits or fingers, the three sets together forming the hand. The first and shortest of the three metacarpals (together forming the metacarpus) bears the thumb or Pollex (to the basal joint of which the bastard wing is attached), consisting of one or two joints (the terminal one frequently absent or aborted); the second and strongest composed of two or three joints is termed the Index; whilst the third, the weakest and most slender, has one joint only. Some few Archaic birds (Ratitæ) possess the second metacarpal only; whilst in the Penguins it is fused with the first. Claws at the tips of the metacarpals are rare in existing birds, although as we have already seen the extinct Archæopteryx was provided with them. In modern birds they apparently mostly appear accidentally upon the thumb and index, and probably in no case are functional. We have seen a pollex claw upon the Common Whitethroat, and such is found in various Anserine birds, in the fowl, and in some Raptorial birds. Conical spurs are not uncommon on the carpal and metacarpal bones, and are often used as weapons.

The bones of the legs or posterior limbs, like

those of the wings, are composed of three principal portions. The first of these is the Femur or thigh, which, as we have already mentioned, articulates with the cup or acetabulum of the pelvis, following which come the Tibia and Fibula, often more or less coalescent and together forming the shank or "drumstick," and lastly the bones of the Foot. Not a little confusion exists, even amongst persons fairly familiar with birds, respecting these three divisions of a bird's leg. The actual thigh of a bird is hidden by the plumage, and the shank (Tibia and Fibula) is often mistaken for it, as the metatarsus is for the shank. The metatarsus is a compound structure formed by the fusion of the second, third and fourth metatarsal bones, which when maturity is reached do not lie in the same plane (except in the Penguins and some Parrots), the third having its upper end thrust backward and its lower end pushed forward during the course of growth. The fifth metatarsal is only seen in the embryotic stage, soon disappearing, whilst the first metatarsal chiefly remains separate, lying in the majority of birds behind the distal part of the others. The metatarsus is covered with a series of angular horny plates or scutellæ, varying

considerably in size in the different groups, in some consisting of a series of fine reticulations, in others of oblong plates, or of both combined, whilst in others yet again the surface of the metatarsal is smooth and "booted." Following the metatarsals come the toes, which form that part of the foot upon which a bird stands or walks. Owing to the transitory character of the fifth metatarsal a bird never shows any trace of a fifth toe. The first toe in not a few cases is aborted, in the Ostrich the second toe is wanting, whilst in two genera of Kingfishers the second toe is aborted: the only instance known of an aborted fourth toe is presented by the Timeliinæ, genus Cholornis. The hind toe (Hallux) has two joints or phalanges only, the second toe or digit possesses three, the third toe four, and the fourth toe five joints. The Swifts, however, are exceptional, having only three phalanges in each of the anterior toes, whilst in the typical Goatsuckers and the Sand-Grouse the fourth digit possesses only four. The toes of birds are modified in an immense number of ways to bring them into harmony with the conditions of life and the various habits of their possessors. In numbers of birds either the hallux or the fourth digit is reversible at will, as in the Owls and to a lesser

extent in the Plantain-Eaters and certain forms of Rollers. In other groups this temporary condition has become permanent, and we have what is termed a "zygodactylous" foot, as presented by the Woodpeckers, Cuckoos, and Parrots. In the Mouse Birds (Colius) the hallux can be brought forward whilst the fourth digit can be turned backwards at will, whilst in some of the Swifts and Goatsuckers all the digits constantly turn forwards, this class of foot being technically called a "pamprodactylous" one. In many water birds the anterior digits are joined together by a membrane, thus forming what we call a webbed foot, so admirably adapted for swimming, whilst in the Pelicans the hallux is also joined to the other digits by a web. The hallux is by far the most variable of the digits, and may either exist on the same plane as the other digits, when it is usually large and of service, or be raised above the others, and is then smaller and without function. This is especially the case in the Wading Birds, in others it is reduced to a mere stump as in the Petrels and certain three-toed Woodpeckers, and in others it is entirely wanting, as in the Auks, Bustards, Ostriches, and allied birds (Ratitæ), and one or two Waders (Sanderling, Grey

Plover). The inner margin of the claw on the third toe or digit of some birds is toothed, serrated, or pectinated as in the Goatsucker, the Herons, the Cormorants, the Coursers, Pratincoles and some of the Grouse.

From the trunk and limbs we pass to the head or rather the skull, the last portion of the avine skeleton we have now to consider. The complicated nature of this part of the skeleton and the large amount of space that would be required to render its description at all intelligible to the average reader, make a detailed notice of the numerous parts here impossible. The student or interested reader may therefore be referred to some standard work on vertebrate anatomy (such as Owen's, or better still the masterly contributions of Dr. Gadow to Professor Newton's *Dictionary of Birds*), where full particulars may be obtained. The various bones of the head, it may be stated, fall naturally into several groups, as, for instance, those forming the Cranium, which includes all the bony and cartilaginous parts of the skull except the jaws and the palato-pterygo-quadrate bones, those appertaining to the visceral arches which give rise to the Hyoid Apparatus, the palate and the jaws. The Bill lends itself to

more popular treatment, and is so closely connected with the habits and characteristics of birds that some amount of detailed description becomes absolutely necessary in a work of the present scope. A Beak (rostrum) consists of an upper jaw or Maxilla, and a lower jaw or Mandible. The bill is divided into several parts by anatomists, chief of which are the culmen or dorsal ridge of the upper bill, the apex or tip, the dertrum or swollen hook in which it often terminates, the genys or ridge or angle of the lower mandible, and the tomia or cutting edges of the bill. The horny sheath or rhamphotheca in which the bones of the bill are enclosed in some cases consists of a number of pieces, but in the majority of cases forms one coherent sheath. In birds of the Duck tribe most of the covering sheath is soft, only the tip or nail being hard and horny; whilst in Raptorial birds and Parrots the distal end of the bill is hard and the basal portion is soft and forms a cere, in which the nostrils are generally situated. The nasal portion of the bill in many birds is soft and furnished with an operculum, as in the Pigeons; whilst in the Petrels this operculum is still more developed and forms a tube. In some birds the horny sheath is curiously modified and swollen

into certain horns, knobs, and protuberances, reaching its climax in the Hornbills and Toucans: the Coots, Swans, and Scoters may be also instanced. Reverting to the nostrils we find certain very distinct classes; those in which the nasal cavities are separated by a septum are termed "impervious," and those in which the septum is incomplete, the nasal cavities communicating, are termed "pervious." Another type of nostril is found in the Cormorants, for instance, in which it is reduced to a mere slit, and becomes still further emphasised in the Gannets, in which the nasals are absolutely closed, and the birds are reduced to exercising the sense of smell through the mouth. The edges of the mandibles in many birds are more or less deeply indented, notched, or serrated, thus enabling the bird better to seize and devour its prey; in the Ducks and allied birds these serrations take the form of lamellæ used for sifting and securing food. Mention should here be made of that small calcareous protuberance at the tip of the upper bill which is developed in the embryonic stage of all birds, and known as the "egg tooth." This "tooth" is used as a file by the chick in freeing itself from the egg-shell, and is cast soon after its purpose has been

fulfilled. It is interesting to remark that a similar "egg tooth" is present in reptiles and used for the same purpose. We might say with perfect truth that the modifications in the form of the bill are almost endless—adapted for every conceivable method of obtaining food. A brief glance at some of the most striking types must however suffice. Passing over the ordinary type of bill which is found in such a large number of birds even belonging to the most diverse families, we have as specially modified forms the broad, depressed, lamellæ-furnished bills of the Duck tribe; the powerful curved and hooked bill of Raptorial birds; the exceptionally strong and rounded bill of the Parrots, so admirably adapted for reducing to pulp the hard nuts and fruits upon which these birds so largely subsist; the chisel or wedge-shaped bill of the Woodpeckers, which enables those birds to reach their prey or excavate their nest holes amongst timber. Then we may instance the lance-shaped bills of the Herons and Divers, adapted to seize fishes, or the broad, flat spatulate bill of the Spoonbills. Or, again, as quite another type, the singularly weak bill of the Swallows, Goatsuckers, and Swifts, almost functionless as a food seizer. The amount of variability in the form of the bill in

some otherwise homogenous groups of birds is most remarkable, and significantly proves with what ease this organ may become modified to meet certain conditions of life. Two of the most striking examples of this are furnished by the Charadriidæ or Wading Birds, and the Trochilidæ or Humming-Birds. In the former group we have hard chisel-shaped beaks in the Oyster-catchers, sharp and slender ones in the Phalaropes, Stilts, and Avocets (in the latter upturned), long and sensitive in the Snipes, arched in the Curlews, heart-shaped or spatulate at the end in the Spoonbilled Sandpiper, and absolutely turned towards the right in that singular form the Wrybill. Little less variable is the modification in the bill of the Humming-Birds, and which can only be described as astonishing. Its abnormal maximum length is reached in the genus Docimastes, in which it is longer than the bird, including the head and tail; whilst its abnormal minimum length attains in the genus Rhamphomicron, in the smallest species of which it is only a quarter of an inch. We find in this family every gradation, from a perfectly straight bill to one so curved or arched as to describe almost one third of a circle, appropriately termed Sickle Bills; whilst in other species it is strongly

recurved like that of an Avocet; another singular modification is presented in the much-compressed bill of birds in the genera Heliothrix and Schistes. In some species the bill is hooked and the edge of the mandible serrated. Amongst the more aberrant types of bill mention may be made of that of the Whale-headed Stork and the Boat-bill (Cancroma) and Shoe-bill (Balæniceps), in which the bill is shoe or boat shaped; of the very curious bill of the Whalebirds (Prion), in which the jaws do not completely close; of the bill of the Skimmer (Rhynchops), which is scissor-shaped, much compressed laterally, and the lower mandible is considerably longer than the upper one. Mention may also be made of the curiously modified bill of the Flamingoes, in which the upper mandible is not only highly mobile, but is much smaller than the lower one, which is almost immovable; and lastly, of the singular formation of the bill of the Crossbills, which, as the name of the birds indicates, has the two mandibles obliquely crossed.

We now pass to a very brief sketch of some of the internal organs of a bird. Here again the various divisions of the internal structure are each so complicated and important that anything like an exhaustive description is impossible

within the limits we have assigned to our treatment of the subject. The Muscular, Nervous, and Digestive Systems of a bird each require the fullest treatment to render the study comprehensive, and any attempt would be more or less futile to condense it in the limited space at our disposal or to bring it at all into proportion with the purely introductory character of the present little treatise. Suffice it then to say, that the muscles of a bird constitute what is popularly known as flesh, and consist of a series of fibres, arranged with their long axes in the direction of the muscles' action, each being in connection with a nerve-cell, the excitement of which causes contraction and the drawing together of the parts to which the whole muscle is attached. Muscles are of two kinds. First, involuntary or unstriped muscles, usually of slow and rhythmical action, belonging to the viscera and the skin : second, voluntary or striped muscles ; whilst the cardiac muscles are to some extent intermediate between the two. The Nervous System of a bird consists of two portions, a Central portion made up of the Spinal Marrow or Cord and the Brain, and a Peripheral portion containing the Cranial and Spinal Nerves with all that relates to the

alimentary and genital organs and the circulation. The Digestive System embraces the Alimentary Canal and its various glandular appendages either embedded in its walls, or like the Liver and Pancreas connected with it by special passages. Its function is to prepare the food, partly by mechanical and partly by chemical processes, and to absorb the nutritive fluid (Chyle) by aid of the lymphatic vessels. The first organ of digestion is the Tongue, which is subject to an immense amount of modification, often; similar in distantly related groups, due to correlation with special modes of obtaining food. In birds the tongue can scarcely be regarded as an organ of taste, although in many species it is of the greatest use in securing prey, and in most is subservient to deglutition. A brief description of some of the principal types of tongue may not be devoid of interest. It certainly reaches its greatest development in birds of the Duck tribe (as well as in the Flamingoes), whilst in the other extreme it becomes reduced to a mere nodule in the Pelicans and Gannets, in some of the Herons, Storks, Hornbills, Hoopoes, Kingfishers, Goatsuckers, Petrels, and Ratitæ birds. In Raptorial birds the tongue is short,

thick, soft, and spatulate; in the Woodpeckers it is exceptionally long, round, narrow, and pointed at the extremity, in some species armed with hooks directed backwards. The tongue of some of the Parrots (Trichoglossidæ) exhibits a brush-like fringe, whilst that of the Toucans (long and slender and non-protusible) is clothed with numerous short bristles along the sides. In the Humming-Birds and Sun-Birds especially the tongue is subject to special modification, and is wonderfully adapted to the mode of feeding. It is extremely long, and in the Humming-Birds consists of a slightly flattened tube towards the base, which divides before reaching the forked part of the organ, and a flange or thin lamella is developed along the outer edge. This flange curls upward and inward and converts the forked tip into two tubes, the anterior half of the flange being more or less fringed. Some of the latter fimbrication, however, appears to be due to the constant use of the flange. Following the tongue comes the Œsophagus or gullet, which in many birds opens into the ingluvies or crop, which is succeeded by the glandular proventriculus or anterior portion of the stomach, which leads to the muscular ventriculus or posterior portion, popularly termed

the gizzard. This latter communicates with the intestines (which vary considerably in length in the various avine groups), which towards their extremity at the beginning of the rectum in many birds are provided with a pair of blind-sacs or lateral dilatations technically called cæca. The presence or absence of these sacs in a functional condition is chiefly dependent upon the nature of the food; and they are most developed in herbivorous species, least so in those that subsist on animal food, and absent in species that subsist on fruit and grain. This, however, is a broad generalisation, there are many exceptions; and in some cases one of these sacs only is present, and that in a rudimentary state. The process of digestion may be thus briefly summarised: after the tongue has played whatever part is assigned to it, the food is swallowed and passes through the gullet assisted by moisture from numerous glands into the stomach. In birds which have a crop, however, the food is subjected to the action of certain secretions which, aided by the heat of the body, exert a softening influence and prepare it for its entry into the stomach. Here again it comes under the influence of secretions from the gastric glands, and is also

subjected to the mechanical process of trituration or crushing (especially in birds that subsist upon grain and consequently possess muscular stomachs) in the gizzard, the action usually being facilitated by the presence of stones, grit, or sand swallowed by the bird to aid digestion. When thus prepared the food then passes on through the pylorus into the small intestine, where in the first loop of which (the duodenum) it is mixed with the secretions of the liver and pancreas, the action of which converts the soluble portions into peptones which are conveyed into the lymphatic system and so into the blood. When present and functional the cæca receive what remains of the food, where still more nutrition is extracted. The remaining waste substance then returns to the rectum, and is finally ejected through the cloaca or vent in the form of fæces or "droppings."

Passing over the organs of reproduction, we come to those of respiration. Here, again, space does not admit of much general description, although we must deal at some length with the organs of voice, which are such a peculiarity in birds. Leading to the organ of voice is the Trachea or windpipe branching at the end into the two Bronchi, each of which enters the lung

on that particular side. The Trachea is a flexible tube composed of a large series of rings, and is the passage by means of which a bird not only breathes but through which most of its notes are uttered. The dilatation of a part of the trachea, usually near the middle, is a feature found in many groups of birds, whilst some of the Anseres even present a second expansion, either close to the larynx or more generally near the lower end. Another remarkable tracheal modification exists in the males of most Anseres, some half-dozen or more of the lowest rings being fused together, and forming what is technically known as the bulba ossea or "labyrinth." In some species of Swans and Cranes the trachea penetrates into the keel of the sternum; the excessive lengthening of the trachea causes it in some birds to be looped. These various modifications exert considerable influence on the cries of certain species, but the song owes its production to another modification at the lower end of the trachea and the adjoining parts of the bronchii. This modification is termed the Syrinx, and is absolutely peculiar to birds. It consists of a series of muscles attached to the extremities of the bronchial semi-rings. These voice muscles reach their highest development

in what are known as the Oscines or Singing Passeres. Most of these birds possess five or seven pairs of syringeal muscles. The four or five distal tracheal rings are fused solidly together into a little box or chamber communicating with the bronchial tubes, the first and second bronchial semi-rings being closely attached to the trachea; and the spaces between the second and third, and third and fourth semi-rings, being generally closed by outer tympaniform or drumlike membranes, whilst the remaining semi-rings are closed by an inner similar membrane. The result of the manipulation of these muscles in endless combinations of rotating and rocking movements is the utterance through this tracheal sounding pipe of those lovely songs for which the true singing birds are so justly famed. Three types of Syrinx are recognised by anatomists, dependent upon the position of the sound-producing membranes, and termed Tracheal, Bronchia, and Tracheo-Bronchial respectively. The first-named type includes birds that possess a loud voice, and form the well-marked group of Clamatore Passeres, confined to the Neotropical Region. In the second type the trachea has no sounding membranes, and includes various Goat-suckers and Swifts, whilst there are certain forms

of syrinx intermediate between this type and the next peculiar to certain Cuckoos and Owls. The third type is the normal one, including the Singing Passeres, its principal features having already been described. Here we may say that the tongue in no way assists the voice in birds; with the possible exception of Parrots in captivity.

Summarising Professor Fürbringer's conclusions respecting the origin of birds, he commences with the supposition that they commenced their descent as toothed forms of small or moderate size, with long tails and four feet similar to those of a lizard, their bodies clothed with a primitive sort of down. These were succeeded by creatures in which the down had become feathers and the fore limbs had become prehensile organs, the hinder limbs chiefly used for progression; these modifications being correlated with a transformation of the legs and pelvis and a fusion of the metatarsals, resulting in a flightless feathered biped. The feathers not only now began to increase in size and stiffness, but various modifications of the skeleton and the muscles eventually endowed these early avine forms with the power of flight. The two species of Archæopteryx are all that remain to

us of this special type, from which, by many modifications, especially in the fore limbs and the caudal region, birds as they exist to-day have sprung.

In conclusion we ought to say that, according to the state in which they are hatched, the young of birds are divisible into two distinct groups, one of which is further separable into two sections. When birds are hatched with their eyes open, and clothed in down, able to run almost directly they break from the shell, and with sufficient food-yolk still in the stomach to provide for immediate wants, they are classed as Præcoces or Nidifugæ. This group includes the Ratitæ, the Tinamous, Game Birds, Sand Grouse, Cranes, Rails, Gulls, Waders, Ducks, Geese and Swans, and the Grebes, Divers, and Auks. When birds are hatched (it may be with their eyes open or closed, or covered with down or naked), unable to leave the nest, and fed by their parents, and with a very small store of food-yolk in the stomach, they are classed as Altrices, or Lower Nidicolæ. This group includes the Penguins, Pelicans, Cormorants, Gannets, Darters, Frigate Birds, Petrels, Herons, Storks, Ibises, and Spoonbills. When, however, the species in the group of Altrices are hatched

blind and helpless, generally naked, fed by their parents for a long period, and with no reserve of food-yolk in the stomach when they break from the shell, they are classed as Higher Nidicolæ. This group includes the Pigeons, Birds of Prey, Owls, Parrots, Cuckoos, all Picarian birds and all the Passeres.

CHAPTER II

THE PRINCIPAL BIRD GROUPS

The two Primary Divisions—The Carinatæ and Ratitæ—Moas and Rocs—Rheas, Cassowaries, and Emus—Kiwis and Ostriches—The Crypturi or Tinamous—The Impennes or Penguins—The Colymbiformes or Divers and Grebes—The Procellariiformes or Petrels—The Pelargiformes or Herons, Storks, Spoonbills, and Ibises—The Pelecaniformes or Tropic Birds, Gannets, Cormorants, Pelicans, Darters, and Frigate Birds—The Anseriformes or Swans, Geese, Ducks, and Mergansers—The Gruiformes or Cranes and allied birds—The Ralliformes or Rails and Finfoots—The Galliformes or Game Birds—The Pediophili or Sand-Grouse—The Columbiformes or Pigeons—The Charadriiformes or Bustards, Plovers, Sandpipers, Jacanas, Sheath-bills, Crab Plover, and Seed Snipes—The Lariformes or Gulls, Terns, Skuas, and Skimmers—The Alciformes or Auks—The Falconiformes or Birds of Prey—The Coraciiformes—The Psittaciformes or Parrots—The Cuculiformes or Cuckoos and Plantain-Eaters—The Passeriformes or "Perching Birds."

WITHOUT leading the student into the hopeless labyrinth of avine classification, it will, I hope, be quite possible to give a brief outline of the various great natural groups into which the kingdom of the Birds is divided by systematists.

Much difference of opinion exists not only respecting the taxonomic value of various anatomical characters, but as regards the affinities and relationships of these groups, as well as the position in the avine system of not a few aberrant forms. But on the other hand opinion is much less divided, if not in complete accord, amongst systematists respecting the composition of the several great groups which we will shortly proceed to describe at some length. Birds naturally separate themselves, as we have already seen, into two great primary divisions—one the Carinatæ, possessing a keel to the sternum, the other Ratitæ, in which this keel is absent. This latter division is composed entirely of birds in which the faculty of flight is wanting; and as Professor Fürbringer seems to have demonstrated, these birds are the retrograde or degenerate descendants of birds that possessed volant powers—the body increasing in bulk as the muscular power of the wings decreased. There can be no doubt that the Ratitæ comprise the most archaic of existing birds, so that we may appropriately commence our survey of the principal avine groups with a brief notice of them. Huxley divided the Ratitæ into five distinct groups, one of which

contains no surviving representatives, and to this number we can with equal propriety add another, thus bringing the number of groups, or, as we will call them, Orders, up to six. These are the **Immanes** or Moas, and the **Æpyornithes** or Rocs, both of which are extinct (confer preceding chapter, p. 10); the **Rheæ** or Rheas, the **Megistanes** or Cassowaries and Emus, the **Apteryges** or Kiwis, and the **Struthiones** or Ostriches. It is difficult to say which of these orders is the most highly specialised, for each exhibits characters which might place it in that position according to the value we may attach to them. This, however, is a matter beyond the province of the present chapter, and we must pass on to a consideration of the chief groups of Carinate birds.

First of these, and, as was suggested by Huxley, a connecting link between the Ratitæ and the Carinatæ, we have that small but very distinct order the **Crypturi** or Tinamous. They number just upon eighty species, and have their home in the forests and on the open plains of the Neotropical region. Tinamous are comparatively small birds, ranging from the size of a Quail up to that of a domestic Fowl, and somewhat closely resemble a Partridge in form

and general colouration. The wings are rounded and short, suggestive of sedentary habits, whilst the general actions somewhat resemble those of the birds in the previous division. The eggs of these birds are very remarkable, the surface of the shell being so highly polished as to resemble burnished metal or glass, and of various striking colours, such as pale yellow, green, blue, rich brown and orange. Another interesting characteristic is that the male bird performs the duty of incubation. But little appears to be known respecting the habits of these curious birds. Tinamous are said by some observers to be somewhat stupid birds, easily captured; whilst their small brain capacity seems to furnish another proof of their comparatively low organisation.

Our next group consists of those exceedingly curious birds the Penguins, which form the very distinct natural order **Impennes,** the Sphenisciformes of some authorities. Perhaps the most remarkable character of the Penguins is their peculiar wings, which are so small and flapper-like as to render the birds absolutely flightless. These abortive wings, however, are of great service to the birds in water, and in some cases are used to assist their owner

in its progress over the land. The plumage is exceptionally dense and compact, covering the entire body. Penguins assume a ventro-podal or erect attitude when on land, and present a very comical appearance as they stand in regiments at their breeding-places, where it may be mentioned they are so absurdly tame that their numbers, in not a few places, have been terribly reduced by man's wanton persecution. Fortunately, they do not frequent the land much except during the breeding season. The water is their natural element, and here they dive and swim with great celerity, aided by wings and feet, very often progressing for long distances just below the surface, appearing every now and then for a moment to breathe. Their notes are harsh and barking. Their food chiefly consists of crustaceans and other marine animals, with fish and scraps of vegetation. Penguins breed in large companies, known as "rookeries," congregating on rocky islands for the purpose, and making a rude nest of grass and leaves, placed in holes, under heaps of boulders, in caves, or amongst the tussocks of vegetation. Their two eggs are very pale bluish-green, coated thickly with a chalky substance, and closely resembling those of

the better-known Cormorants. The incubation of these is apparently undertaken by both sexes (the birds standing over them like Auks), and the young are fed for a considerable time. Regular paths to the water's edge are frequently trodden by the birds in going to and leaving their nests, which in some cases are a mile or so from the sea. The largest Penguin known stands about a yard high, the smallest about half that. More than a score species of Penguin are known to science.

Considered by some authorities to be somewhat closely allied to the preceding, we have now to glance at the **Colymbiformes**, an order which contains (as two sub-orders) the Divers and the Grebes. These birds, whether so closely related as some recent morphologists think, or not, certainly form an archaic group, and at the same time a very distinct one. The order is one of the smallest in the avine kingdom, the Divers numbering less than half-a-dozen species, the Grebes not more than twenty-five or so. Both Divers and Grebes are eminently aquatic, the feet of the former being webbed, those of the latter furnished with lobes. The legs are situated very far back, whilst the metatarsi are very much flattened—a peculiarity which offers least resistance to the water

between each stroke. They swim and dive with wonderful skill, and also possess the habit of sinking themselves at will in the water until perhaps only the tip of the beak is exposed. Their plumage is dense and compact, whilst the Grebes possess the peculiarity of having the tail-feathers aborted. Both Divers and Grebes stand upon the metatarsus, and the ventropodal position has been claimed as their exclusive attitude upon land, but the evidence does not warrant this (Conf. *Bird Life in a Southern County*, p. 251). The flight of the Divers is rapid and strong, some of the species performing long migratory journeys; the Grebes are not such strong fliers, perhaps, but many of the species are migratory. Some of the latter birds are famous for the crests and tippets that they assume just prior to the breeding season. The Divers make slight nests upon the ground and lay two spotted eggs; the Grebes make a more or less floating nest—a large mass of vegetation with a cavity at the top in which the half-dozen eggs are deposited. These are very elliptic in form, white in colour and chalky in texture. The Divers feed principally upon fish, the Grebes upon aquatic insects, molluscs, crustaceans, small fish, and various vegetable fragments. The notes

of the Divers are loud and unearthly screams, mostly heard during the nesting season, but those of the Grebes are more feeble and of a croaking description.

Another archaic and fairly distinct order is the **Procellariiformes,** which includes the Petrels, the Fulmars, the Shearwaters and the Albatrosses. They are all pelagic birds, and remarkable for their great power of wing. Their chief external characteristic is the tubular nostril, a feature that serves to identify them at a glance. They vary in size from about that of a Sparrow (the Storm Petrel, or "Mother Carey's Chicken," the smallest web-footed bird known) to that of a big Goose (the Albatross Diomedea exulans, one of the largest of volant birds, and with an expanse of wing of upwards of twelve feet). All the species have the anterior toes connected by webs ; all swim well and buoyantly, and many of the smaller species possess the habit of pattering the surface of the waves with their feet, running as it were over the water, hence the name of Petrel derived from the Apostle Peter ; but their most usual province is the air. They are the feathered nomads of the wide ocean wastes, and rarely visit the shore unless to breed, or when driven to do so by exceptionally violent

storms. None of the species is remarkable for any brilliant coloured plumage, the prevailing tints being blacks, browns, greys, and white. In all known species the sexes are similar in colour. Many of the species are of nocturnal habits, especially the smaller forms of Petrels and the Shearwaters, but the Albatrosses and Fulmars are chiefly diurnal. Some of the most remarkable forms in this order are the Diving Petrels, which appear to be more terrestrial in their choice of haunt, frequenting fiords and inlets. These birds possess the habit of diving, but little seems to be known respecting their economy. The notes of these birds are harsh, cackling, and grunting. The birds often become very vociferous at night at their breeding-places. Some of the species are remarkably silent, notably the Fulmars. These birds breed on remote ocean islets and lonely coasts, some burrowing into the ground, others making their rude nests upon the earth, or on cliffs or amongst boulders. None of the species lays more than one egg for a brood, and this egg is white and chalky, in some cases sprinkled or dusted with a zone of reddish-brown spots. They feed upon crustaceans, cephalopods, jellyfish, and similar marine creatures, varied in some cases with scraps of sorrel

and other vegetation. This order contains about one hundred species.

Our next order, the **Pelargiformes,** is by no means such a homogenous one as those that precede it. It includes the Herons, the Storks, the Spoonbills, and the Ibises, each of which may be again divided into a sub-order or at least a family, some of the latter yet separable into various sub-families. These are all long-legged birds, and most possess a sufficient family likeness to render their identification with the group fairly easy. Their long wings, long necks, and long spear-shaped bill (except in the Spoonbills, in which it is spatulate, and in the Ibises, in which it is arched and slender like that of a Curlew) are also other characters which are common to the order. It is impossible here, with the very limited space at our disposal, to enter into any detailed description of the numerous sections into which the Herons may be divided. All we can do is briefly to enumerate the most striking. First we have the Herons proper, of which our own British species may be taken as typical; then come the smaller Herons, the graceful Egrets, the Night Herons, the Bitterns, and Little Bitterns, and lastly that somewhat aberrant and highly curious form the

Boat-bill (Cancroma). As a group the Herons are semi-aquatic, and frequent lakes, rivers, swamps, and morasses, and the flat sea-coasts. They are birds of powerful if somewhat laboured flight, and walk with ease and grace. Their notes are harsh and guttural, and singularly weird and booming in the Bitterns. They feed on fish, small mammals, birds, reptiles, insects, crustaceans, worms, and molluscs. Their usually bulky nests, made of sticks, rushes, grass, leaves, and roots, are either placed on trees or cliffs or amongst the dense vegetation of the swamps and marshes. The eggs are generally bluish-green, but white in some cases and brown in others. Many of these birds are exceptionally graceful, being adorned either constantly or during the nuptial season with mazy plumes and long pendent crests and gorgets; others are of brilliant green or brown or black, in some cases loricated with metallic sheen. The Spoonbills and the Ibises are very similar in their economy to the Herons, but the eggs are of a different type, especially in the former. The Storks again form a small group quite apart from the rest of the order. The typical Storks bear resemblance to the Herons in general appearance. One of their most salient

anatomical characteristics is the absence of syringeal muscles and their consequent want of voice, the only sounds they make being those produced by clappering or striking the mandibles together. Their habits and mode of reproduction are very similar to those of the Herons, but their white eggs are very characteristic. Some of the more aberrant forms are very interesting, including the Adjutant (Leptoptilus) with its enormous neck pouch; the Jabiru (Mycteria) standing five feet high, with its bare head and neck; and lastly the still more extraordinary Open-bills (Anastomus), so termed because of the wide gap between the two mandibles near the point. The curious Shoe-bill (Balæniceps), and the Hammer-head (Scopus) are aberrant forms, which may possibly be associated with the Storks, although opinion is divided as to their kinship. Perhaps they are deserving of at least family rank.

Another heterogeneous order is the **Pelecaniformes**, the Steganopodes of Illiger and some other authorities, included in the same order as the foregoing by others. We include within it the Tropic Birds and Gannets, the Cormorants, Pelicans, and Darters, and the Frigate Birds. They are all aquatic birds, and mostly marine

in their habitat, the three last named being least so. The birds in this order are characterised by the peculiar structure of the feet, the interior toes as well as the hallux or hind toe (which is turned forwards) all being connected by a web. The birds in the various groups (or perhaps sub-orders) vary considerably in structure and appearance. Thus in the Tropic Birds and Frigate Birds the head is large and the neck is comparatively short and stout. In the Cormorants and Darters the head is small, but the neck is long, especially so in the last-named birds. The Pelicans are furnished with a large pouch between the angle of the lower jaw. The bill is long, straight, and usually compressed, cone-shaped and pointed in the Gannets and Tropic Birds, terminating in a more or less stout hooked nail in the Cormorants and Frigate Birds; in the Darters, long, slender, and pointed. The legs are placed far back. The wings are long and ample (least so in the Cormorants), as might naturally be expected in such an assemblage of aerial species. In many species the face and gular region are bare, the latter often furnished with a sac. The tail varies considerably, from the soft rectrices of the Pelicans to the rigid ones of the Cormorants and Darters. In the Tropic

Birds the central feathers in the tail are much prolonged; in the Cormorants and Gannets it is wedge-shaped; in the Frigate Birds it is acutely forked; in the Darters it is broad and fan-shaped. The wing bones of the last are very specially modified, the furcula coalescing with the coracoids, whilst the latter similarly join with the proximal end of the scapula, resulting in a nearly rigid framework. This peculiarity is believed to be closely connected with the extraordinary soaring or sailing flight of these birds. The neck of the Darters also presents us with a feature believed to be unique amongst birds, the eighth vertebra articulating with the seventh nearly at a right angle, causing a "kink," whilst the muscles connected with this are also specially modified, the whole forming a beautiful apparatus by which the birds secure, with the least possible exertion, the fish upon which they subsist. We also find great diversity of plumage in this order, from the pure white of the Gannet or the Pelican (in the latter with a rosy blush) to the bottle-green of the Cormorant, or the loricated blackish-brown of the Frigate Bird. In many species elaborate nuptial filoplumes and other ornaments are assumed. In most species the young are hatched naked, but soon

assume a downy covering, whilst in the Tropic Birds and Frigate Birds they are hatched with a coat of down. Most of these birds are comparatively silent; but the Gannets are perhaps the noisiest at their breeding-places. The nests are usually made upon the ground, or in trees or on cliffs, the birds generally breeding in large societies, but the Tropic Birds do not make any provision for their eggs. The Tropic Birds, Gannets, Pelicans, and Frigate Birds lay one egg only for a sitting, which is mostly white and chalky, but spotted with brown in the Tropic Birds; the Cormorants and Darters lay several eggs for each sitting. Fish is the principal food of the birds in this order.

As it is impossible to indicate or express the relationships of the different groups one to another in a linear series or arrangement, it is quite immaterial in what sequence we deal with the various orders, so we may now next glance at the **Anseriformes.** This is one of the most self-contained and natural of the avine groups, becoming absolutely homogeneous if we restrict it to the Swans, Geese, Ducks, and Mergansers, but in it must also be included the Screamers and Flamingoes. Both these latter must be regarded as very aberrant forms,

and are certainly entitled to rank in separate sub-orders. The Screamers (Palamedeæ) can scarcely be regarded as web-footed, for the membranes between the long toes are rudimentary. In this group the uncinate processes to the ribs are wanting, a character not found in any other existing birds. The bill is short and stout, a horn or caruncle starts from the forehead of one species, and the wings are armed with two sharp spurs. Another curious feature is the series of air cells between the skin and the muscles, producing a crackling sound when the body is pressed. These birds swim well, and to some extent resemble the Waterhens in their habits. The eggs are white, and the young are clothed with down. The Flamingoes (Phœnicopteri) are more Anserine in their affinities, but some of these may be due to analogy. They stand to some extent midway between the Storks and the Geese. Their most striking external features are the long legs and long neck. We have already dwelt upon the singular formation of the bill in this group. The anterior toes are webbed. These birds build conical nests of mud, and lay but a single chalky-white egg for a sitting. The young are hatched covered with down.

The sub-order Anseres (the Swans, Geese, Ducks, and Mergansers) contains birds that cannot readily be confused with the members of any other order or group. Their most characteristic external features are their generally broad flat bills, furnished with a nail at the tip of the upper mandible, which are either serrated or furnished with lamellæ, and their webbed feet, all the anterior toes being united by a membrane. The bill varies a good deal in shape, from the short sub-conical one characteristic of the Geese to the broad spatulate one of the Shovellers and the narrow elongated one of the Mergansers, or furnished with a small hook in the latter, and some others. The chin-lobe in the genus Biziura is remarkable. The wings in some species are armed with spurs. The tail varies a good deal in shape, but is generally short, rounded in some, cuneate in others, and less frequently singularly spine-like and rigid. The peculiar formation of the trachea in some species in this order has already been alluded to (*conf.* p. 49). A marked similarity of habit runs through the birds of this sub-order—all, or nearly all, the species are eminently aquatic, marine or inland. Most are gregarious at some time of the year or another. The peculiarities

of their moulting have been dwelt upon in the previous chapter. The food is partly of a vegetable and partly of an animal character. The nest is placed on the ground, more or less plentifully lined with down from the parent, in holes of trees or cliffs, in burrows, and exceptionally in low bushes or trees. The eggs are numerous, buff or green of various shades, or white in colour, with considerable gloss. The young are hatched covered with down. These birds with few exceptions fly well, swim or dive, and many are of migratory habits. Upwards of two hundred species are included in this order, all save nine belonging to the Anseres.

The next order we shall notice is a small one, the **Gruiformes** or Cranes and allied birds. Small as this order is, it is a most heterogeneous one, and is composed of the Cranes, the Limpkins, the Kagu and the Trumpeters. Each of these is worthy of at least family rank, the Cranes (nineteen species) constituting the Gruidæ, the Limpkins (two species only) the Aramidæ, the Kagu (one species) Rhinochetidæ, and the Trumpeters (six species) Psophiidæ. Some authorities include the Sun Bittern (Eurypygidæ) and the Seriemas (Cariamidæ) in the present order. Both represent swimming forms

of some ancient type, and to assign them a natural place in the avine classification is a well-nigh hopeless task. The Cranes are a group of large wading birds, long-necked and long-limbed. The bill is stout, and about as long as the head, the nostrils enclosed by a membrane, and the nasal groove extends more than half the length of the upper mandible. The peculiar modification of the sternum and the trachea has already been described (*conf.* pp. 31, 49). The wings are long and ample, the inner secondaries developing into drooping plumes which partially conceal the short tail. The young are hatched covered with down. Cranes live in swamps and on vast open plains, and are remarkable for their extended migrations. Their flight is powerful and sustained. Their notes are loud and trumpet-like. They make their nests on the ground in the swamps, and their two or three eggs are handsomely marked. They feed on grain, seeds, shoots and leaves, lizards, snakes, and small mammals. The Limpkins present features which ally them to the Cranes on one hand and to the Rails on the other. They frequent streams and marshes, make a nest on the ground, and lay numerous white eggs spotted with brown and purple. The Kagu is a most

extraordinary bird, about as big as a fowl, with a long pendent crest, and the wings are beautifully marked and spotted with white, buff, and black. This bird during periods of sexual rivalry or excitement indulges in a mad sort of reel, spreading out its parti-coloured or spangled wings, and then seizing the tip of its tail or that of one wing in its bill, begins to whirl round and round, producing a most novel effect. The Trumpeters are also remarkable birds, somewhat Fowl-like in size and appearance, with long legs and long necks. They are gregarious and dwell in swampy forests, rarely fly, but run with great speed, and it is said swim when hard pressed. Their cry is loud and far-sounding. The food consists of fruit, grain, and insects. They make a nest upon the ground and their eggs are whitish.

Our next order is the **Ralliformes**, comprising the Rails and Finfoots, with which we may also perhaps include the single species of Mesites. The Rails by themselves constitute a pronounced homogeneous group, but the inclusion of the Finfoots and Mesites introduces a heterogeneous element. By some ornithologists the Finfoots are relegated to a separate order, and Mesites is referred to a sub-order

of the Gruiformes, or even included in the Galliformes. The Finfoots here forming a separate family only (Heliornithidæ), although obviously allied to the Rails, are probably a more archaic and less specialised group. They number but four species. The anterior toes have broad scalloped webs. The young are reputed to be hatched naked, but next to nothing is known of the reproduction in this family. Their general habits are Rail-like. The single curious form constituting the family Mesitidæ has the toes without webs or scallops, and the presence of powder-down patches (*conf.* p. 17) is a special feature. The bill is long and slender, the wings rounded, the lores and orbits are naked. But little is known of this curious bird's habits. The Rails are remarkable for their much compressed body, comparatively short rounded wings, long legs and toes, the latter sometimes furnished with webs and scallops. Some of the Rails are incapable of flight, and consequently these in most instances are threatened with extermination. The bill, in this order, is subject to considerable variation; long and comparatively weak in the Rails, short and stout in the Crakes, and strongest of all in the Gallinules. In not a few cases the forehead is

furnished with a frontal shield, usually of some conspicuous hue, or with large caruncles and knobs. In some cases the wing is furnished with a spur. The tail is small, and sometimes almost concealed by the coverts. Most of the Rails are frequenters of swamps and marshes and the banks of pools and streams, but some of them evince a partiality for drier districts. They are somewhat graceful birds in their carriage and progress upon the land; their flight is laboured, and usually undertaken with reluctance, nevertheless many of the species are migratory. They swim and dive with great skill, and in some cases are somewhat addicted to climbing and perching in trees. The notes, generally speaking, are loud and startling, and of a very distinctive character. Their food consists of both animal and vegetable substances. As a rule the Rails are not very social or gregarious. The nests are generally made on the ground amongst aquatic vegetation, or are anchored amongst reeds and rushes some distance from land. They are made of various kinds of vegetation. Some few are said to breed in burrows, others to make spherical structures. The eggs are mostly numerous and spotted. The young are hatched covered with down.

We will next pass to a consideration of the large and important order called **Galliformes**, which includes what are popularly known as "Game Birds." Except for one or two trifling exceptions, they may be described as a homogeneous group composed of perhaps half-a-dozen families. The most aberrant forms associated with the Galliformes, in the arrangement here adopted, are the Megapodes (Megapodiidæ), the Curassows, Guans and allied forms (Cracidæ), and the Hoatzin (Opisthocomidæ). These have been accorded the rank of a sub-order by some systematists, but family distinction only seems to us sufficient. Morphologically the Megapodes appear to be the lowest of the entire order, confirmatory of which may possibly be their very peculiar method of reproduction, the birds burying their eggs in the ground or covering them with a heap of mould and leaves, and thus leaving them to be hatched by the sun's rays or the warmth generated by the decaying vegetation. The Curassows and Guans closely resemble the Megapodes in structure, but their habits are very different. They frequent arboreal haunts, and make their nests in trees. It is said that Guans interbreed with domestic Fowls. The Hoatzin is certainly the most aberrant form of

all, but resembles the Gallinaceous type more closely than any other. Various anatomical modifications render this species unique among birds, the most remarkable of which is that the sternum is furnished with a keel only on the posterior part, the anterior part being aborted; the double crop is also unusually capacious, and rests upon the furcula or wish-bone and the fore part of the sternum. Another most interesting peculiarity is that the young birds (which are able to run as soon as they are hatched) possess two claws on the wings (on the index and pollex) which they use to climb about the branches with, hooking them over the twigs, and progressing with the additional aid of bill and feet. The most typical families contained in the order Galliformes consist of the Pheasants, Partridges, Quails and allied birds (Phasianidæ); the Hemipodes (Turnicidæ), raised to the dignity of a sub-order by some ornithologists; the Grouse (Tetraonidæ); the Guinea Fowls (Numididæ); and lastly, the Turkeys (Meleagridæ). With the limited space at our disposal it is impossible to describe even the chief peculiarities of these several families, but the following characteristics are practically common to the entire order. The sternum contains two very deep notches on the

posterior margin; the episternal process is perforated to receive the base of the coracoids, except in the Hoatzin. The hind toe is always present, but varying in size and position; the body feathers have a well-marked hyporhachis or aftershaft. The bill is comparatively short and stout, curved and wide at the base, the upper mandible overhanging the lower one. The wings are comparatively short and rounded; the tail is most variable, not only in shape but in number of rectrices. The young are hatched covered with down, and able to run as soon as hatched. In no other order do we find greater diversity of external characters. The great variety and brilliancy of the wattles, combs, and excrescences that decorate the head, the development of spur, the magnificent colours and bewildering variety in the plumage, and the wonderful modification of the tail-feathers and coverts, would require many pages of description to do them justice, whilst a similar remark applies to the diversity of habits. About 400 species and races are known.

Following the Galliformes we have here to notice another small and yet very characteristic order, namely the **Pediophili** or Sand-Grouse. The position of these birds in the avine system

seems yet to be an undecided point. By some authorities they have been included in the same order as the Pigeons; by others they have found a place among the Game Birds. A more recent authority has referred them to a sub-order of the Charadriiformes. Whatever their affinities, there can be no doubt that the Sand-Grouse form a very highly specialised group, and at the same time possibly a very archaic one. Sand-Grouse are birds about the size of a Partridge, with a bill resembling that of the Game Birds, but the wings are long and pointed, adapted for prolonged and powerful flight, the outermost primary in one species having the shaft prolonged into a filament; the tail is wedge-shaped, the central feathers much prolonged and slender. The feet are more or less covered with dense short plumes; and in two species the hallux is wanting, and the anterior toes are enclosed in a kind of sheath or "podotheca," the whole forming a padded foot, and a feature unique amongst the class Aves. Sand-Grouse are dwellers on deserts and rough scrub-covered plains; some of the species are migratory or nomadic. They are more or less gregarious. Their food consists of grains, seeds, and vegetable substances. They make but a scanty nest upon the ground, and

their three eggs are very oval in form and spotted with surface and shell markings. The young are hatched covered with down. Sixteen species of Sand-Grouse are at present known to science.

From the Sand-Grouse we may conveniently pass to the **Columbiformes** or Pigeons, a remarkably homogeneous and well-defined group, composed of nearly 500 species (470 are recognised in the British Museum Catalogue). These birds are allied apparently to the Game Birds, through the preceding order, and to the Plovers. Some authorities divide this order into two sub-orders, but as one of these (Didi) is exclusively composed of extinct forms (the Dodo and the Solitaire), we need not stay to consider them. All living members of this order, according to Count Salvadori, their most recent monographer, are divisible into five families (some of which are again made up of several sub-families). These are the Treronidæ or Fruit Pigeons, Columbidæ or Typical Pigeons, Peristeridæ or Ground Pigeons and Doves, the Gouridæ or Crowned Pigeons, and the Didunculidæ or Tooth-billed Pigeons, of which but one species is known, and that is threatened with extermination. Pigeons vary considerably

in size, the largest being the Crowned Pigeons, which are nearly as big as a Goose, and the smallest are included in the Doves, and are scarcely as large as a Skylark. The Pigeons all bear such a "family resemblance" that none of them can be readily confused with any other birds. Perhaps their most striking external feature is the somewhat Plover-like bill, enlarged and hardened at the tip (which is modified into a decided hook in the Tooth-billed Pigeon) and covered at the base with soft skin, in which the nostrils, partly concealed by an incumbent valve, are situated. The metatarsus is more or less feathered (except in some of the small Doves); the anterior toes are moderate in length, but the hallux is small. The plumage is dense and compact, and the hyporhachis is absent from the contour feathers or rudimentary only. It is impossible here to give the many features of the various families and genera. All that we can say is that the predominant colour is grey or brown, often loricated on the neck and breast with metallic sheen, but in some genera the birds are brilliantly arrayed in purple, gold, green, and red. Pigeons as a group are arboreal in their habits, but some species show a partiality for rocky or even barren districts.

Many of the species are gregarious at some time or another; some are migratory. The flight is powerful and well sustained. Their cooing notes seem common to the entire group. Their food consists principally of grain, seeds, shoots of vegetation, and fruits. The nests generally are slight platforms of sticks, but some species breed in holes of trees or rocks, others on the ground. The eggs are normally two in number, but in some forms three are said to be laid, in others but one. These are always white, or some pale shade of cream in colour. The young are hatched blind, but with a clothing of thin yellowish down, and are dependent upon their parents for a long period. As a rule incubation in this group is performed by both sexes.

Our next order will be the **Charadriiformes.** This may be taken to include the Bustards, Plovers, Sandpipers, and Jacanas, together with the aberrant and more generalised and archaic forms known as the Sheath-bills, the Crab Plover, and the Seed Snipes. Some or all of these may possibly require to be included in several sub-orders; all of them at least deserve family rank. The present order may be said then to consist of nine fairly well defined

families, some of which are divisible again into sub-families. These are the Otididæ or Bustards, the Œdicnemidæ or Stone Curlews, the Cursoriidæ or Coursers, the Glareolidæ or Pratincoles, the Charadriidæ or Plovers, Sandpipers and Snipes, the Parridæ or Jacanas, the Dromadidæ or Crab Plovers, the Chionididæ or Sheathbills, and the Thinocorythidæ or Seed Snipes. The number of species contained in this order is nearly three hundred. In point of size the Bustards are by far the largest, some of these weighing between twenty and thirty pounds or more, whilst the Stints may be classed as the smallest, with a body less than that of a Sparrow. There is great diversity in the external characters of the birds composing the present order, and in none more so than the bill. In the Bustards (of which thirty species are recognised) the bill is stout and somewhat flattened, and without the swollen tip characteristic of so many other forms in this order, a peculiarity which is also marked in the short and curved bills of the Seed Snipes, Coursers, and Pratincoles. In the typical Plovers the point of the bill is hard and swollen into what is technically called a dertrum ; in some of the Sandpipers it is hard at the tip (Totaninæ);

in others, although hard at the tip, it is provided with a small number of nerves (Scolopacinæ), which in the typical Snipes become much more abundant. We have already alluded to the form of the bill in this group (*conf.* p. 42), so that little more need be said here. Mention, however, might be made of the horny covering or case at the base of the upper jaw of the Sheath-bill, and the frontal plates and curious wattles that adorn the head of certain Lapwings or Jacanas. The birds in the present order are terrestrial, with long legs and necks more or less, and with, in most cases, ample wings. The toes are subject to considerable variation, from the short ones of the Bustards to the exceedingly long and slender ones of the Jacanas (the latter birds being enabled by them to run over floating vegetation); in some cases (as in the Avocets) the anterior toes are united with a complete web, in others they are semi or partially webbed at the base, or furnished with lobes, as in the Phalaropes. In some forms a few of the primaries are attenuated. The tail-feathers also vary considerably in number and shape. The birds in this order are more or less gregarious, especially during winter. They run and walk well, many swim, and not a few

are known to perch in trees. Their food is partly animal and partly vegetable substances. They usually nest upon the ground, making a slight provision for the eggs, which are generally four in number. These as a rule are handsomely marked and pyriform in shape, but the Crab Plover is said to lay a white egg and to breed in a burrow. The young, almost without exception, are hatched clothed in down, and able to run about soon after leaving the shell. We may also mention that many species are migratory.

Following the Charadriiformes, and certainly closely related to them, come the **Lariformes** or Gulls, Terns, Skuas, and Skimmers Here again we have a remarkably homogeneous assemblage of birds, possessing external characteristics which prevent them from being confused with any others. This order may be conveniently subdivided into four well-marked sections, only one of which, however, is worthy of more than sub-family rank. These are the Gulls (Larinæ), the Terns (Sterninæ), the Skuas (Stercorariinæ) and the Skimmers (Rhynchopinæ). Possibly the Skuas form a distinct family, as will be seen below. The birds in this order have the anterior toes united by a web. The bill in the

typical Gulls is strong and the upper mandible is curved; in the Terns it is nearly straight and pointed, in the Skuas it terminates in a distinct hook, and furnished with a naked cere at the base, whilst in the Skimmers it is much compressed, and the lower mandible is a great deal longer than the upper one (*conf.* p. 43). In the two first-named groups the metatarsus is moderately long, but in the two latter groups it is proportionately shorter. The claws are weak in all groups except the Skuas, in which they are curved and sharp. The wings are long and pointed, especially so in the Terns and Skimmers—birds that may be said almost to live in the air. The tail varies considerably in shape; nearly square in most of the Gulls, more or less acutely forked in many of the Terns, and the two central feathers projecting beyond the others (acute in some species, curiously twisted in another) in the Skuas. These birds are all aquatic in their habits, and most of them are marine. Many frequent inland localities to breed, others are partial to lakes and rivers. They are more or less gregarious at all seasons, and not a few are migratory. They fly well and buoyantly, having great command over themselves in the air, swim equally well, but do not

dive. Some species (Terns) plunge like Gannets to secure their prey. They feed largely on fish, but may be described, as a group, as practically omnivorous. Their notes are harsh and unmusical. The Skuas obtain much of their food by chasing and robbing other Gulls of their prey. They breed on the ground or rocks, the Gulls and the Skuas making more or less elaborate nests, but the Terns provide little or no accommodation for their eggs. These are mostly three in number, sometimes two, and in exceptional instances four, and richly marked with spots and blotches. In this order the sexes are nearly alike in colour. The prevailing tints are grey and white in the adult Gulls and Terns (often with a black hood or crown), browns and yellow in the adult Skuas. The immature birds are mostly mottled brown of various shades, whilst the young are hatched covered with down. Some hundred and ten species are known.

Another allied group is the **Alciformes** or Auks, which, although it contains but a single family (Alcidæ), is composed of birds presenting considerable variation of structure and plumage, especially of the head. The order comprises the Auks (of which the recently

extinct Great Auk or Gare Fowl was the largest known representative, as big as a Goose, but incapable of flight), Guillemots, and Puffins, numbering some thirty species. Now that the Great Auk is gone, the members of the present order are all comparatively small birds, ranging from about the size of a small Duck to that of a Thrush. They are web-footed, the anterior toes being united by a membrane; the metatarsus is short, and the legs are placed so far backward as to render their gait clumsy. But this is compensated by their exceptional swimming and diving powers, all the members of the order being as active in the water as the fishes themselves. The wings are short and narrow, nevertheless the birds fly well and rapidly, sometimes for long distances; the tail is short, either rounded or graduated. In some forms (the Puffins) the eyes are decorated with horny growths, and rosettes of skin are displayed about the mouth; whilst nuptial plumes, often of a most eccentric character, ornament the head during the pairing season. Small as this order is, the birds composing it present an extraordinary amount of variation in the form of the bill. First we have the long pointed bill of the Guillemots, then the

deep laterally compressed coulter-shaped bill of the typical Auks, and the short arched bill of the Little Auk, and lastly the still more laterally compressed and deeper bill of the Puffins, with its wonderful series of horny sheaths or appendages, assumed during the breeding season and lost in autumn (*conf.* p. 28). The Auks are all pelagic birds, and as a rule only resort to the land to breed. They are more or less gregarious at all seasons, but especially so during the time of reproduction, when they congregate at certain time-honoured spots to rear their young. They are comparatively silent birds, their notes being harsh and grunting. Their principal food is fish and small marine animals. The Guillemots and Auks make no nest, but lay their one, or in exceptional cases two eggs either on the rock ledges or in chinks and fissures; the Puffins usually burrow into the soft ground or select a suitable crevice amongst cliffs or even masonry, and form a rude nest of dry grass, at the end of which they lay one egg, exceptionally two. The eggs of the Auks and Guillemots are almost without exception very handsomely marked, and present such a variety of colour as to render detailed

description here impossible; the eggs of the Puffins are mostly dull white, with but a few faint rusty and grey spots and blotches: the egg of the Little Auk is pale greenish-blue. The prevailing colours of the Auks are black or sooty-brown above, and white below. The young are hatched covered with down, but are tended by the parents for some considerable time.

This concludes our review of web-footed birds, and we now pass again to quite a distinct type, the **Falconiformes** or Birds of Prey. This is another exceptionally homogeneous order, composed of birds with special features that preclude them from being confused with any others. We may briefly diagnose them by the external characters of the strong hooked or notched bill with its basal cere, and the lateral position of the eyes, to which may be added in the majority of species the long, powerful, hooked and sharp claws. The Birds of Prey are divisible into at least two sub-orders, one of which contains the American Vultures only (Cathartæ), and the other (Accipitres) is separable into four very distinct families. These are the Secretary Birds (Serpentariidæ), composed of one species only; the Old World Vultures (Vulturidæ); the Eagles,

Hawks, Falcons, Harriers, and allied birds (Falconidæ); and lastly the Ospreys (Pandionidæ). The American Vultures present various important anatomical differences from their Old World representatives, among which may be mentioned the perforated nostrils, the small elevated hallux, and the absence of syringeal muscles. Included in this sub-order is the remarkable Condor. Of the Old World sub-order Accipitres, the most aberrant form is the Secretary Bird, a long-legged bird, more like a Crane than a Raptor in appearance, standing more than a yard high, with a conspicuous nuchal crest, and the two central tail feathers more than double the length of the rest. Its partiality for snakes and other reptiles ensures it protection from man. The Old World Vultures are externally characterised by the absence of feathers from the head, the frequent presence of a ruff round the neck, blunt claws, and the absence of a "tooth" or notch in the hooked bill. They are for the most part eaters of carrion, and though gifted with marvellous powers of flight, are comparatively sluggish birds. They build huge nests of sticks, &c., and their eggs, one or two in number, are white or variously marked with reddish-brown and grey. The next family is by far the most extensive, and

contains such distinctive groups as the Eagles, the Bearded Vultures, the Carrion Hawks, the Hawks, Harriers, Buzzards, Kites, and typical Falcons. Although in such a large assemblage of birds we meet with much diversity of form and plumage and habits, the general characteristics are present which sharply define the group from all others—the same short stout bill, curved and hooked, the same powerful feet armed with talons, the same powerful wings (if differing in length and form). Great diversity of size is also present, for we have only to compare the mighty Sea Eagles with the diminutive Falconet no bigger than a sparrow! But little tendency to gregariousness is exhibited, although in some cases marked social habits are presented. They frequent almost every description of scenery—from the sea-coast to the mountain tops, from the ice-clad regions to the steaming forests of the Equator. Gifted with keen sight and smell, they hunt their prey in a great variety of ways, and their food is of an animal nature. Their nests may be placed in almost every kind of situation, from the ground to the tops of trees and beetling precipices. Their eggs may be either pale blue and spotless, or richly ornamented with blotches and spots of reddish-brown

and grey. The young are hatched covered with down, but remain in the nest until fledged. Not a few of the species are migratory, and some must be classed amongst the most widely ranging of birds. The Ospreys are specially remarkable for the structure of their feet. The outer toe is reversible, and the soles of the feet are thickly covered with spicules, whilst the claws or talons are exceedingly curved and sharp. These birds live on fishes, which they catch by plunging upon them like a Gannet or a Tern. In their reproduction they closely resemble the typical forms. About 350 species are included in this order.

The next order we shall notice is the **Coraciiformes**, a most heterogeneous assemblage, which is divisible into no less than seven sub-orders and nineteen families, each of which constitutes a fairly compact group. The first of these sub-orders (Coraciæ) includes the Coraciidæ or Rollers, the Momotidæ or Motmots and Todies, the Alcedinidæ or Kingfishers, the Meropidæ or Bee-eaters, the Bucerotidæ or Hornbills, and the Upupidæ or Hoopoes. The second (Striges) includes the Strigidæ or Owls. The third (Caprimulgi) includes the Caprimulgidæ or Goatsuckers, the Podargidæ or Frogmouths, and the

Steatornithidæ or Oil Bird. The fourth (Cypseli) includes the Cypselidæ or Swifts, and the Trochilidæ or Humming-Birds. The fifth (Colii) includes the Coliidæ or Colies, an isolated little group. The sixth (Trogones) includes the Trogonidæ or Trogons as its only representatives. The seventh (Pici) includes the Galbulidæ or Jacamars, the Bucconidæ or Puff Birds, the Capitonidæ or Barbets and Honey-guides, the Rhamphastidæ or Toucans, and the Picidæ or Woodpeckers and Wrynecks. It is absolutely impossible even to give the leading characteristics of such a number of diverse groups (containing a grand total of nearly 1800 species) in the space at our disposal. The affinity of the Owls with the birds in this order and not with the Birds of Prey is, however, specially worthy of mention; as is also the fact that among the species above enumerated are to be found some with plumage of the most gorgeous colours in the avine class.

Next in order of sequence come the **Psittaciformes** or Parrots. Here we have another of those homogeneous groups containing birds that cannot readily be confused with those in any other order. Although displaying an infinite variety of colour, and differing greatly in size and general appearance, the Parrots may be

readily distinguished from all other avine forms by their characteristic beak and zygodactylous feet. The former is in most species short and strong and arched, the upper mandible mobile and loosely articulated to the skull, the lower mandible truncated: the base of the bill is furnished with a cere. The Parrots (numbering about five hundred species) may be divided into half-a-dozen fairly well defined families as follows: the Stringopidæ or Owl Parrots, of which but a single species is known; the Psittacidæ or Typical Parrots; the Cacatuidæ or Cockatoos; the Cyclopsittacidæ; the Loriïdæ or Lories; and the Nestoridæ or Keas. The Owl Parrot or Kakapo (Stringops habroptilus) is apparently unable to fly, spending its time upon the ground or climbing about the trees, balancing itself with its short rounded wings. Otherwise the wings in this order are fairly long and powerful; the tail varies considerably in shape, short and square, elongated, wedge-shaped, and in some species the central feathers are bare of barbs except at the tips, where they form racquets. In this order the colours are often gaudy, and displayed in the loudest of patterns. Parrots are of gregarious habits. Their food consists principally of nuts, fruits, buds, leaves,

roots, grain, &c., and some species are more or less insectivorous. As is well known, these birds often hold their food with their feet. Many of these birds are arboreal, but others frequent herbage-covered plains and rocks. Their flight is somewhat slow and laboured; upon the ground they walk with ease, and in the trees climb about the branches, aided by their bill. Their notes as a rule are harsh and discordant. Parrots are monogamous, and nest in holes of trees or rocks, or in the ground; but a few forms are said to make globular nests amongst the grass. They make little or no nest as a rule, and the eggs vary from one to a dozen in the various species, the larger forms laying the fewest and the smaller forms the greatest number. The young are hatched naked, and remain in the nest holes until fledged.

Passing on from the Parrots we come to the **Cuculiformes** or Cuckoos and Plantain-Eaters. These may be divided into two very distinct groups; by some authorities raised to the dignity of sub-orders, by others regarded as only of family rank. The latter view will be taken here. The Cuculiformes then will consist of the Musophagidæ or Plantain-Eaters, and the Cuculidæ or Cuckoos. The latter family may

be again separated into half-a-dozen sub-families, which we will shortly specify. Taking the Plantain-Eaters first, we find that they differ from the Cuckoos in several important respects, although obviously very closely allied to them. The feet in this sub-order are only semi-zygodactylous, the outer toe being reversible. The bill is stout, the culmen being rounded or compressed and serrated or denticulated along the margin. In two species the base of the bill is modified into a frontal shield. The contour feathers are furnished with an after-shaft; the wings and tail are rounded, the latter composed of ten rectrices. All the species but one possess erectile fan-like crests. Plantain-Eaters either live in companies or in scattered pairs. They are arboreal species, shy and restless, and feed on fruits, insects, worms and, it is said, small birds. Their notes are loud and discordant. Their flight is somewhat uneven, yet on occasion well sustained. So far as is known, the Plantain-Eaters construct rough platform-like nests in the branches, and their eggs are pale blue. The young are hatched naked. A very remarkable peculiarity should be mentioned respecting the plumage of these birds. The crimson feathers yield a peculiar

pigment, named by Professor Church "turacin," and containing copper, soluble in water. This colour is not unfrequently washed out if the birds get their plumage wet, although it is subsequently regained.

The Cuckoos are distinguished by their complete zygodactyle feet, and the absence of an aftershaft to the contour feathers. The bill is very variable in shape, nearly straight, curved, arched, and in some few species exceptionally large, or the upper mandible laterally compressed into a mere plate. The wings are long and pointed in the migratory species, more rounded and concave in sedentary forms. The tail, consisting of ten feathers (except in a single sub-family, the Crotophaginæ, where they are only eight), is usually long, and either square, fan-like or wedge-shaped. In some species the upper tail coverts are half or quite as long as the rectrices or tail-feathers. Some of the Cuckoos are remarkable for their occipital crests, whilst bifurcate feathers are frequent on the head and neck. Some of the species are remarkably social, others are as solitary in their habits. There are arboreal and terrestrial species. Their food consists of insects, larvæ, reptiles, small animals and birds, and in some cases seeds and berries

are said to be devoured. Their notes are loud, distinctive and peculiar, some of their cries being quite a feature in certain lands. There is great variety in the nesting arrangements of the Cuckoos; some of the birds make nests and hatch and care for their young in the usual way; but the majority are parasitic, dropping their eggs into the nests of other birds and taking no further interest in the welfare of their offspring. The young are hatched naked. The various sub-families into which the Cuculidæ is divided are as follows: First, the Cuculinæ, of which our own Common Cuckoo may be taken as typical. Second, the Centropodinæ or Coucals, long-legged Cuckoos, mostly terrestrial in their habits, and having the hind toe furnished with a long straight spine-like claw; they are non-parasitic, and their eggs are white and of chalky texture. Third, the Phœnicophainæ or Couas, and Rain Birds, partly arboreal and partly terrestrial; the former of heavy flight and good climbers, the latter seldom perching: they are non-parasitic, and their two or three eggs are white. Fourth, the Neomorphinæ, which includes the curious Chaparral Cocks, terrestrial species, capable of running with great speed, and rarely using their short wings; they are non-parasitic, and lay

three or four white eggs. Fifth, the Diplopterinæ, a very small group, containing but three species; and Sixth, the Crotophaginæ, containing the Anis. These are sociable birds, and curiously enough when breeding several females join and share the same nest. About a couple of hundred species of Cuckoo are recognised.

Our last order consists of the **Passeriformes** or "Perching Birds." It is by far the largest of the groups into which the birds of the world have been divided, containing some 5500 species, or not quite half the number of existing avine forms. The subdivision of this enormous assemblage of species can scarcely be said to have been satisfactorily accomplished, although not a few systematists have essayed the task. The present order contains the most highly developed birds. Some authorities remove the Broadbills (Eurylæmidæ) and the Lyre Birds (Menuridæ) from the Passeriformes, and raise each of them to the dignity of a separate order; other ornithologists refer them to distinct families in the order just named. The separation of the Lyre Birds has the very significant fact of the nestling being thickly clothed in down to support it; whilst the Broadbills have certain anatomical peculiarities to warrant

their being kept apart. The remaining Passeres may be conveniently divided into four lesser groups, viz., the Oscines or Singing Passeres, the Oligomyodæ or Non-singing Passeres, the Tracheophonæ or South American Passeres, and the Atrichornithes or Australian Scrub Birds. The number of families into which each of these sections or groups should be divided, is quite impossible to say, scarcely two authorities agreeing in this respect. Some systematists admit no fewer than thirty-seven in the Oscines, which includes the Crows, Starlings, Orioles, Finch-like birds, Larks, Creepers, Titmice, Shrikes, Waxwings, Thrushes, Wrens, Timeline Birds, Flycatchers, Swallows, and so on. This is by far the most extensive group. The Oligomyodæ is made up of eight families, and includes such forms as the Tyrant Birds, the Manakins, the Cotingas (which includes the curious Umbrella Bird and Bell Birds), the Plant-cutters, and the Pittas. The Tracheophonæ consists of three families, the Wood Hewers (among which must be numbered the Oven Bird), the Ant Thrushes, and several genera of very aberrant birds classed as the Pteroptochidæ. The Atrichornithes comprise a single family of peculiarly modified birds, having the clavicles or furcula rudimentary. It

is quite impossible to enter into greater details concerning this vast assemblage of birds, which vary in size from the Raven, say, to the Goldcrest, and although differing but little in structure present an amount of variation in colour, in form, in song, in general habits and economy, that can only be described as amazing. The Passeriformes represent the latest stage of avine evolution; they are unquestionably the most highly specialised as they are the most abundant and dominant of all avine life. The two most important characters that distinguish these birds from all others are the ægithognathous palate, in which the vomer is truncated anteriorly and not connected with the maxillo-palatines; and the anterior toes are connected with the flexor perforans digitorum, and the hallux by the flexor longus hallucis. There are many birds that superficially resemble the Passeriformes, so that external characters are comparatively useless.

CHAPTER III

THEIR DISTRIBUTION IN SPACE

The geographical distribution of birds—Views of Sclater, Huxley, and Wallace—Dr. Sclater's Zoological Regions—The Palæarctic Region: its characteristic birds—The Ethiopian Region: its characteristic birds—The Indian or Oriental Region: its characteristic birds—The Australian Region: its characteristic birds—The Nearctic Region: its characteristic birds—The Neotropical Region: its characteristic birds—Distribution of the Moas and Rocs—Distribution of Ratitæ birds—Distribution of Carinatæ birds—The Tinamous—The Penguins—The Divers and Grebes—The Petrels—The Herons, Storks, Spoonbills, and Ibises—The Tropic Birds, Gannets, Cormorants, Pelicans, Darters, and Frigate Birds—The Screamers, Flamingoes—Swans, Geese, Ducks, and Mergansers—The Finfoots and Rails—The Cranes, Trumpeters, Seriemas, and Sun Bitterns—The Game Birds—The Sand-Grouse—The Pigeons—The Plovers and Snipes, &c.—The Gulls, Terns, Skuas—The Auks—The Birds of Prey—The Coraciiformes—The Parrots—The Cuckoos and Plantain-Eaters—The Passeriformes, or Perching Birds.

In the two previous chapters we have dealt with the Origin and Salient Characteristics of Birds, and with the chief groups or orders into which they are divided. Naturally we come next to

the Geographical Distribution of Birds, or the way in which the various species that compose those orders are dispersed over the earth's surface. In the previous chapter we commenced by dividing living birds into two great sub-classes, the Rheas, Cassowaries, Emus, Kiwis, and Ostriches forming one of these, called Ratitæ, and all remaining birds forming the other, called Carinatæ. Ratitæ birds we have divided into four orders with living representatives, whilst Carinatæ birds have been separated into twenty orders. Let us now briefly consider how the various species that form these twenty-four orders of birds are distributed over the earth's surface. The first really scientific effort to do this was made by Dr. Sclater, who divided the world longitudinally into six great avifaunal regions. This was followed a few years later by a scheme of which Huxley was the author, in which he considered that the earth's surface was better divided latitudinally, and that four regions were preferable to Dr. Sclater's six. Eight years later still, Dr. Wallace published his great book on the geographical distribution of animals, in which he adopted Dr. Sclater's views, and these have been more or less generally accepted ever since. Although many grave

objections can be urged against the longitudinal regions sketched out by Dr. Sclater, and although personally we consider that the whole subject will require serious modification, and that some scheme of latitudinal division will yet be proved to be the correct one, we think that for the purposes of the present little work these six, or perhaps five (as we shall shortly learn), regions may be recognised. Dr. Sclater's six regions were named respectively as follows: I. the Palæarctic Region; II. the Ethiopian Region; III. the Indian, or as it is frequently termed, the Oriental Region; IV. the Australian Region; V. the Nearctic Region; and VI. the Neotropical Region. There is now, however, a very widely prevailing opinion amongst naturalists that New Zealand should form a separate region, and that the Palæarctic and Nearctic Regions should be amalgamated, and called the Triarctic or Holarctic Region. It is not possible here to describe the many sub-regions and provinces into which the half-dozen regions have been subdivided, although we may roughly define the geographical limits of the latter and briefly indicate their most characteristic avine features, before sketching out the distribution of the various orders.

The **Palæarctic Region** may be said to include Europe from Iceland eastwards, Africa north of the Sahara, with the island groups of the Canaries, Madeira, and the Azores, and the whole of Asia, including Japan, with the exception of South Arabia, India, the Burmese countries, Malaysia, and the southern half of China. Among the most characteristic birds of this region may be instanced the typical Warblers, the Accentors, the Magpies, Nutcrackers, Bullfinches, typical Buntings, and Pheasants, and all those northern and arctic forms so many of which, however, are common to the Nearctic region, and thus furnish one of the strongest arguments for amalgamating these two areas. The **Ethiopian Region** is one of the most compact of these zoological realms, and consists of the whole of Africa south of the desert, but including the whole of Egypt and, of course, the island of Madagascar. Its peculiar bird types include the Vulture Crows, the Plantain-Eaters, the Colies, the Oxpeckers, Guinea Fowls, and Ostriches. The **Indian** or **Oriental Region** includes South Arabia, India, and the remaining portions of Asia lying south of the limits of the Palæarctic portion of that continent. Among the types peculiar to this region may be mentioned the Laughing Thrushes, Tailor Birds, Barbets,

Hornbills, certain Cuckoos, and the Jungle Fowls. The **Australian Region** may or may not include New Zealand and the surrounding islands, as we have already explained, but otherwise is made up of Australia, New Guinea, and all the other islands situated to the north of that continent as far as Celebes, together with the whole of Oceania (or the islands of the Pacific) excepting the Galapagos. Amongst its vast and varied avifauna mention may be specially made of the Piping Crows, Birds of Paradise, Honey-suckers, Lyre Birds, Frog-mouths, Cockatoos, Mound Birds, Emus, and Cassowaries. The **Nearctic Region** includes Greenland and the whole of North America as far south as Mexico. A special feature of its avifauna is the many points of similarity between it and that of the Palæarctic Region, but amongst its most characteristic forms we may name the Wood Warblers, the Greenlets, Blue Jays, Tyrant Birds, Hangnests, Mocking Birds, Wild Turkeys, and Turkey Vultures. The **Neotropical Region** comprises the remaining portions of the American continent, from Mexico southwards to Cape Horn and the few outlying islands of the southern seas. This region is perhaps the richest of all in birds, among some of its special and most dominant groups being

the Tanagers, Ant Thrushes, Manakins, Humming-Birds, Macaws, Puff Birds, Toucans, Motmots, Curassows, Tinamous, Trumpeters, Sun Bitterns, and Penguins.

We will now proceed to give a brief outline of the geographical distribution of the various orders already described in the previous chapters. We may at once dismiss those extinct orders, including the Moas, which were apparently peculiar to New Zealand, and the Rocs which, as we have already seen, were confined to Madagascar, and pass on to the remaining four orders of Ratitæ birds. The first of these include the Rheas, birds exclusively confined to the Neotropical Region, to the pampas and dry open plains. The second order includes the Cassowaries and Emus. The former birds are distributed over the islands of the Malay Archipelago—Ceram, Aru, Jobi, New Guinea, New Britain — and North Queensland in Australia. The Emus are confined to the Australian Continent, though formerly inhabiting Tasmania and some of the adjoining islands. The third order includes the Kiwis, those curious flightless birds, doomed possibly to early extinction, which are confined to New Zealand. The fourth order of Ratitæ birds comprises the Ostriches (whether

three species or one seems to be still a moot point), the largest of existing avine forms, now peculiar to the Ethiopian Region, from Arabia southwards to the Cape Colony, although there is evidence to show that their range once extended into the deserts of South-western Asia. As might naturally be inferred these archaic birds are all of comparatively restricted distribution—last survivors as it were of once wide-spread dominant groups, holding on to existence in a few isolated spots, and sooner or later doomed to pass completely away from the world, where now they seem so quite out of place amongst more highly organised Carinatæ birds.

Taking the twenty orders of Carinatæ birds in the same sequence as in the preceding chapter, we have first to glance at the distribution of the Tinamous. These birds are peculiar to the Neotropical Region, where they range from Mexico southwards to the extreme limits of Patagonia. Following these comes the order containing the Penguins. These birds are confined to the Southern Hemisphere, where they may be said to range from the Galapagos Islands on the Equator southwards into the Antarctic regions as far as man has yet explored. They are birds of the

southern seas, having their breeding stations on various lonely islands right round this portion of the world, between the Cape of Good Hope and Cape Horn. Our next order is composed of the Divers and Grebes. Of these two families the Divers are essentially an arctic and sub-arctic group, confined to the northern portions of the Nearctic and Palæarctic regions, furnishing another instance in support of the view held by some naturalists that these two areas should be merged into one. The Grebes, on the other hand, are cosmopolitan in their dispersal, and more or less generally distributed throughout the world in all suitable places, almost from one pole to the other. The next order, the Petrels, is equally as cosmopolitan in its distribution, only instead of land, these birds are dispersed far and wide over every ocean on the globe. Perhaps they are most numerous in the southern seas, and although as a group so universally distributed, many of the species appear to be very local, at all events during the breeding season, almost the only time when they normally visit the land.

The Herons, Storks, Spoonbills, Ibises, and one or two other aberrant species that compose

the order Pelargiformes (the next in our sequence) are, taken as a group, cosmopolitan in distribution, but some of the families are more or less localised. The Herons and Spoonbills are thorough cosmopolites, although the latter do not extend into high latitudes, and are absent from most parts of Oceania. The Storks form the next most wide-ranging family, most abundantly dispersed over the Old World, where they are represented in every Region, and least so in the New World, where, however, they occupy both the Nearctic and the Neotropical Regions. The Ibises are nearly cosmopolitan, but do not extend into the colder zones. Both Storks and Ibises are absent from the Pacific Islands. The remarkable Shoe-bill (Balæniceps rex) is restricted to the central portions of the Ethiopian Region; whilst the equally aberrant Hammer-head (Scopus umbretta) is found over most parts of that region, including Madagascar. Passing on to the Pelecaniformes, the order, taken collectively, is a most thoroughly cosmopolitan one, but many of the families which compose it are of somewhat restricted distribution. Taking the half-dozen families separately, we have the following facts. The Tropic Birds

are oceanic in dispersal, and practically confined to tropic and warm temperate parts of the seas in both hemispheres. Of the three species one roams over the greater part of the Atlantic Ocean, the Indian Ocean, and the Pacific Ocean ; another has a very similar range, but is not known to occur in the western portions of the Indian Ocean, whilst the third is absent from the Atlantic Ocean, but frequents the other two oceans. The Gannets are another oceanic family chiefly confined to the warmer portions of the great oceans, although extending to Iceland in the Atlantic and to the Cape and Australian seas in the south. The Cormorants are nearly cosmopolitan, but do not penetrate very far into the Arctic Regions, and are apparently absent from Oceania, although exceptionally abundant in New Zealand, including the Chatham Islands. The Pelicans are a widely distributed group represented in the warm and tropical parts of every zoological region. The Darters are similarly scattered over the warmer portions of these regions, although unlike the Pelicans absent from Europe, and only just entering the Palæarctic Region in Palestine. The two species of Frigate Birds are distributed

over the tropic seas right round the world, but one of them is apparently much more local than the other, confined to the Eastern seas.

The Anseriformes constitute collectively another absolutely cosmopolitan order, but two of the sub-orders have a distribution considerably more restricted. These latter are the Screamers, which are confined to the Neotropical Region, and the Flamingoes occupy the tropical portions of Asia (with South Europe), Africa, and America, but are absent from Australia. The birds composing the sub-order Anseres are the great cosmopolites. The distribution of the various sub-families into which the Anatidæ is divided is as follows. The Swans are somewhat remarkable in their dispersal, because their area of distribution is a discontinuous one. Swans are distributed over the arctic and temperate portions of the Palæarctic and Nearctic Regions and the more southern parts of the Neotropical Region, whilst the Black Swan is exclusively Australian. Geese, of which several sub-families are recognised, are practically cosmopolitan. The more typical Geese are all Northern Hemisphere species, some of which are specially arctic in their distribution. Ducks may be classed as absolutely cosmopolitan, but

many of the genera are significantly geographical. Thus Dendrocygna is a tropical genus, its members being found right round the world; Chenalopex ranges over the Ethiopian and Neotropical Regions; Tadorna and Casarca (Sheldrakes) are Old World forms; Chaulelasmus is confined to the Northern Hemisphere; Pœcilonetta is common to South America and the Ethiopian Region; Elasmonetta is peculiar to New Zealand; Nesonetta (a flightless species) is confined to the Auckland Islands; Malecorhynchus to Australia and Tasmania; Heteronetta to the southern portions of the Neotropical Region. The cosmopolitan genera are Nettion or Teals, Anas or Typical Ducks, and Spatula or Shovelers; whilst Querquedula (Garganey) is found over the Northern Hemisphere and the Neotropical Region; and Dafila (Pintails) is cosmopolitan, with the exception of Australia and New Zealand. The sub-family containing the Diving Ducks and Eiders is almost exclusively a Northern Hemisphere one, with the exception of the genus Nyroca (Pochards), which is cosmopolitan; Metopiana, which is Neotropical; one of the five species of Fuligula which inhabits New Zealand, the Auckland and Chatham Islands; and Tachyeres, confined to the Strait

of Magellan and the Falkland Islands. Many of these Ducks are arctic or sub-arctic in their distribution during summer. That containing the Musk Duck (Erismaturinæ) is distributed over the Australian, Palæarctic, Ethiopian, Nearctic, and Neotropical Regions; that containing among other forms the Swift Ducks of the Andes (Merganettine) is confined to New Zealand, Waigiu, and the Andes of the Neotropical Region; whilst that containing the Mergansers and Smews (Merginæ) is partly Nearctic and Palæarctic, and also distributed over a portion of the Neotropical and Oriental Regions together with the Auckland Islands. Few other homogeneous groups are more erratically dispersed, although the significance of such a distribution is as yet little realised by ornithologists.

The Gruiformes are another wide-ranging order, although many of the species included in it are considerably localised. The Typical Cranes are represented in all the great zoological regions, with the exception of the Neotropical Region, or at least only just entering the extreme north of that area as winter migrants. A considerable number of Cranes are found in the Palæarctic Region, whilst others are found in the Oriental and Ethiopian Regions; the

Nearctic Region claims two species and the Australian Region one. Of the more aberrant forms composing this order we have the Trumpeters, confined to the tropical portions of South America; the Limpkins, another special avine feature of the Neotropical Region; whilst the still more aberrant Kagu is confined to New Caledonia, a remote island of the Pacific. For geographical purposes we may as well here allude to the Seriemas and the Sun Bitterns, which are both peculiar to the Neotropical Region.

The Ralliformes are another cosmopolitan order confined to no particular area, and universally distributed, with the exception of the Polar Regions, whilst some of the species contained therein are remarkable for their exceedingly extensive distribution. In this group we have many species confined to islands, some of them having entirely lost the power of flight. It is also a most significant fact that some of the genera or families are indigenous to the tropic zone right round the world—a phenomenon of distribution that is utterly opposed to any theory of Polar dispersal and also to all the accepted canons of Distribution. The two outlying and aberrant families are the Finfoots and

Mesites. Both these are of somewhat local distribution, although in the former their geographical area can only be described as enormous, extending from the Neotropical Regions across the Ethiopian Region to parts of the Oriental Region (Burma, Assam, Malacca); whilst the latter, consisting of two species only, is confined to Madagascar. As a group the Rails are practically cosmopolitan, although many of the subfamilies and genera are confined to restricted areas. The Typical Rails, the Crakes, Typical Gallinules, and the Coots are distributed over most parts of the earth; the Purple Gallinules are most numerous perhaps in the Oriental and Australian Regions, although represented in the Neotropical and Ethiopian Regions, as well as in South Europe; the Weka Rails are an avine feature of New Zealand; the curious Ypecaha Rails are exclusively Neotropical: other genera are distributed over various islands in the Pacific. One of the most widely ranging of Ralline birds is the familiar Corncrake of our own English meadows.

Yet another wide-ranging cosmopolitan group has now to be considered, the Galliformes, or Game Birds, and various allied forms. Perhaps no other order of birds is more cosmopolitan in

its geographical distribution. Its representatives are found almost as high in the Arctic Regions as land is known, in every temperate zone, and throughout the tropics and equatorial regions. Many of the families and genera, however, are limited in distribution, and some of the more specialised or aberrant forms are extremely local. These it may be as well to deal with first. One of the most compact and geographically self-contained of these sub-groups is the Curassows and Guans, which are distributed over the Neotropical Region from Mexico southwards. Their dispersal is largely dependent upon forests, in which they love to dwell, and their limits are practically confined between the two tropics. Returning to the Old World we have that other aberrant family, the Megapodes, which forms such a distinctive avine feature of the Australian Region. Mound Birds are distributed over most parts of Australia, but do not inhabit New Zealand. Northwards the family is well represented among the various islands from New Guinea to the Philippines and westwards to the Nicobars, the species inhabiting the latter islands being, however, so isolated from the others of the family and yet so closely allied to some of them, that doubts have been expressed

as to whether it is strictly indigenous to that locality. Last of the aberrant Galliformes comes the Hoactzin, a species confined to the tropical portions of South America. There are many points of interest about the distribution of the Typical Game Birds. Many of the families are strictly geographical. Thus the Grouse are confined to the Nearctic and Palæarctic Regions—to the Northern Hemisphere in fact—another fact in support of the contention that these two regions should be merged into one. Then there are two distinct groups, each composed of Partridges and Quails, having representatives in the New World and the Old World respectively. Then again the Pheasants are almost exclusively confined to Asia, whilst the Turkeys are just as completely a feature of America. The Guinea Fowls entirely belong to the Ethiopian Region, and the Hemipodes are restricted to the Old World. Many of the sub-families and genera again are confined within comparatively narrow geographical limits, as, for instance, the Peacocks to the Oriental Region, the Jungle Fowls (from which the various breeds of domestic Fowls have been derived) to India and Malaysia, the beautiful Polypectrons to India, China, and Malaysia, and so on.

The Pediophili, or Sand-Grouse, are a small order, entirely restricted to certain portions of the Eastern Hemisphere. It is most abundantly represented in the arid desert districts of the Ethiopian Region, and in similar localities in the central portions of the Palæarctic Region. Sand-Grouse occur sparingly in the Oriental Region, and still more so in the extreme south-west of the Palæarctic Region. The next order, the Columbiformes, or Pigeons, may be said to be almost cosmopolitan in their distribution, although they are very unequally divided amongst the various zoological regions. In the first place they are by far the least abundant in cold or northern latitudes, so that the Palæarctic and Nearctic Regions are the poorest in species. The Ethiopian Region also is not very abundantly represented; the Neotropical Region is much richer, as is also the Oriental Region; whilst the Australian Region is remarkable for the abundance and variety of this order of birds. This latter region is undoubtedly eminently favourable to the development of the Columbiformes. It abounds in islands, and thus affords those facilities for isolation so favourable to the establishment of new species, and is singularly free from the many predaceous animals—especially

monkeys — that in other parts of the world have unquestionably checked the increase and development of birds in this order. As a proof of the richness of this region in these birds we may state that the number of known species of Pigeons contained in it is nearly equal to that in all other parts of the world combined. Many of the genera are very local, confined to a single island or group of islands. The most widely ranging groups are the Typical Pigeons (Columba) and the Turtle Doves (Turtur), the former of these being nearly cosmopolitan with the exception of the Australian Region, the latter is not represented in the New World, and is absent from nearly the whole of the Australian Region. Roughly speaking, the distribution of the five families is as follows. The Fruit Pigeons (Treronidæ) are all natives of the Old World, common to the Oriental and Ethiopian Regions. The Typical Pigeons (Columbidæ) are cosmopolitan within the limits already indicated, as are also the Ground Pigeons and Doves (Peristeridæ). The Crowned Pigeons (Gouridæ) are very local, confined to New Guinea and a few of the neighbouring islands; whilst the Tooth-billed Pigeon, the sole member of its family (Didunculidæ), is the most local of all, and restricted to the

Samoa Islands, one of the Australian sub-regions.

The Charadriiformes are another great cosmopolitan order, included in which are some of the most widely distributed of all avine forms. It is, as we have already seen (*conf.* p. 82), a very composite order, made up of no less than nine more or less distinct families, the geographical distribution of which may be thus outlined. First we have the Bustards (Otididæ), confined exclusively to the Old World, birds of a decidedly Ethiopian type. The Typical Bustards are found in three out of the four zoological regions of the Eastern Hemisphere, being only absent from the Australian Region; whilst the Ruffed Bustards penetrate into every Old World region. Following the Bustards come the Stone Curlews (Œdicnemidæ), a small family, yet with a comparatively wide area of dispersal, which includes the temperate and tropical portions of the Old World and the Neotropical Region in the New World. The third family consists of the Coursers (Cursoriidæ), distributed over the Ethiopian and Oriental Regions and the southern portions of the Palæarctic Region. The fourth family, the Pratincoles (Glareolidæ), has a very similar distribution, but also includes Australia. The fifth family, which

includes the Plovers, Sandpipers, and Snipes (Charadriidæ), is the most cosmopolitan one of all, divisible into at least eight sub-families, details of the distribution of which are as follows. The Oyster-catchers (Hæmatopodinæ) are practically cosmopolitan in their distribution; the Typical Plovers (Charadriinæ) are the same, ranging over the entire earth almost from pole to pole. Many of the genera, however, are confined to certain areas, and the distribution of many species is considerably more restricted during the breeding season than in winter. The Stilts and Avocets (Himantopodinæ), a small assemblage of species, are almost cosmopolitan, the only exception being high northern and high southern latitudes. The Turnstones (Strepsilinæ), numbering but a couple of species, one almost cosmopolitan, the other confined to the New World. The Phalaropes (Phalaropinæ) are restricted to the Northern Hemisphere, chiefly to the arctic and sub-arctic portions. The Wattled Lapwings (Lobivanellinæ) are distributed over the Oriental, Ethiopian, and Australian Regions, including New Zealand abnormally, but not Oceania. The Semi-web-footed Sandpipers (Totaninæ) are another widely dispersed group, but most abundantly distributed over the arctic and sub-arctic portions of the

Northern Hemisphere, especially during summer. The Cleft-footed Sandpipers and Snipes (Scolopacinæ) are nearly cosmopolitan, but most dominant during summer in the Arctic Regions. Returning now to the families, the sixth of these, the Jacanas (Parridæ), are found in the Tropics right round the world; the seventh, the Crab Plovers (Dromadidæ), contains but a single species, which is distributed round the coasts of the Indian Ocean. The eighth contains those aberrant birds the Sheath-bills (Chionididæ), which are restricted to various islands in the southern seas, such as the Falklands, South Georgia, Kerguelen, and the Crozets. The ninth and last family contains the Seed Snipes (Thinocorythidæ); these birds are distributed over the southern or temperate portions of the Neotropical Region.

Our next order, the Lariformes, is also a most cosmopolitan one, distributed over the seas and coasts of the entire earth almost from pole to pole. The three families, comprising the Gulls, Terns, and Skuas respectively which are included in this order, are each cosmopolitan in distribution, but some of the genera are very locally dispersed, some being confined to high arctic latitudes, others to

the temperate or temperate and tropic zones, others yet again being restricted more or less to the equatorial littoral. On the other hand the succeeding order, the Alciformes, is limited to the temperate and arctic portions of the Northern Hemisphere. The Auks (in which we include the Guillemots and Puffins) are a special feature of the wild rock-bound coasts of the northern seas, just as the Penguins (although but remotely related) occupy similar localities in high southern latitudes. Specially remarkable in the distribution of these birds is the exceptional abundance of species of Puffins in the North Pacific, so many of them being famous for their nuptial crests and other ornaments.

Following these we have now to consider the distribution of the Falconiformes. Here again we have a group of perfectly cosmopolitan birds, penetrating far into the Arctic Regions, and well represented in every continent, and in almost every island of any importance suited to their needs. Of the two sub-orders into which the present order may be naturally divided, the American Vultures (Cathartæ) are exclusively confined to the New World. The remaining sub-order, the Accipitres,

containing all other known forms of Raptorial Birds, is divisible into four families, the geographical distribution of which may now be briefly sketched. First of these the Secretary Birds (Serpentariidæ), of which but one species is known, is confined to the Ethiopian Region. Next we have the Old World Vultures (Vulturidæ), which are distributed over the warm parts of the Palæarctic Region, the whole of the Ethiopian Region, and a great part of the Oriental Region. Rather noteworthy is the fact that these birds are absent from Madagascar and Ceylon, from the tropical islands of the Malay Archipelago, and from the entire Australian Region. Following these we have the Typical Raptores, including the Eagles, Hawks, Falcons, Harriers, and so on (Falconidæ). Of the various groups or sub-families into which this may be divided, we have the Carrion Hawks (Polyborinæ), mostly confined to the Neotropical Region, but extending into the Nearctic Region as far north as California; the Bearded Vultures (Gypaëtinæ), an Old World group confined to the mountain ranges in the south of the Palæarctic Region, from Spain to North China, and to various parts of the Ethiopian Region; the Buzzards and Kites

(Buteoninæ) may be classed as cosmopolitan, with the exception of Oceania, where they are very poorly represented (New Caledonia); the Eagles (Aquilinæ) are also practically cosmopolitan, especially in the great continents; the Hawks, Harriers, and allied species (Accipitrinæ) are even more generally dispersed, except in very high latitudes; lastly, the Falcons (Falconinæ) are of almost universal distribution, but they are scarcely represented in Oceania. Not a few of the genera in this as in other sub-families of Raptorial birds are somewhat local, and occupy well-defined geographical limits. Last of all come the Ospreys (Pandionidæ), a small family of two or three species, yet wide-ranging and distributed over most parts of the world, except the south temperate portions of the Neotropical Region.

Next in our order of sequence comes the Coraciiformes, comprising no fewer than seven sub-orders and nineteen families. As an order it is absolutely cosmopolitan, but taking the families separately, we shall find that the majority of species are confined to the tropical or subtropical regions of the earth. The distribution of these families is as follows. The Rollers (Coraciidæ) are chiefly characteristic of the

Oriental and Ethiopian Regions (one very abnormal species constituting the sub-family Leptosomatinæ being restricted to Madagascar), but extend into the temperate parts of the Palæarctic Region, and are also found in the Australian Region. One species is curiously isolated on the island of Celebes. The Motmots and Todies (Momotidæ) are a small group of American birds, the range of the former extending from Mexico and the Antilles to Paraguay, that of the latter restricted to the greater Antilles. The Kingfishers (Alcedinidæ), although as a family very universally distributed, are not only localised but unevenly dispersed. The present headquarters of the Kingfisher family are in the eastern portions of the Malay Archipelago, an area specially remarkable for the number of peculiar forms of these birds that occupy it. It is also a remarkable and interesting fact that but one genus of Kingfisher is represented in the New World, and that by a single species, although this vast region is apparently so well adapted to the requirements of these birds. In the Old World the Palæarctic Region is the poorest in species, as the Australian Region is the richest, although the family is well represented in the Ethiopian and Oriental Regions. The genera,

of which the English Kingfisher and the Pied Kingfisher of Europe are members (Alcedo and Ceryle), are the most widely dispersed, as some of the genera of the Australian Region (such as Cittiura, Caridonax) are the most local and restricted. The Bee-Eaters (Meropidæ) form another purely Old World group, which, like the Rollers, are most characteristic of the Ethiopian and Oriental Regions; but their range is not quite so extensive as that of those birds in the Eastern Palæarctic and the Australian Regions. The Hornbills (Bucerotidæ) are a special avine feature of the Ethiopian and Oriental Regions, entering the Australian Region as far as the Solomon Islands. The curious Hoopoes (Upupidæ) are another dominant Ethiopian type, extending into the Palæarctic Region in the west as far as South Europe, in the east as far as North China and Mongolia; whilst they are also found throughout the continental portions of the Oriental Region and in Ceylon.

The second sub-order contains the Owls (Striges), long included with the Birds of Prey, but with affinities more nearly approaching the Goatsuckers. They are absolutely cosmopolitan in their distribution, extending not only to the Arctic Regions, but to many isolated oceanic

islands. Some few of the species in this order occupy enormous geographical areas, among the most remarkable being the Barn Owl and the Short-eared Owl. Many of the genera are common to the Old and New Worlds; a lesser number are limited to the Eastern Hemisphere, whilst a few are similarly restricted to the Western Hemisphere. The Snowy Owl is a feature of the Arctic Regions as the Burrowing Owl is of the American prairies; whilst the Hawk Owl is most typical of the northern woods.

Following the Owls we come to the apparently nearly allied Goatsuckers, forming the sub-order Caprimulgi, under which term are included three families. This sub-order may be classed as almost a cosmopolitan one, except that it is not represented in New Zealand or in some of the most isolated of the islands in the Pacific, nor does it penetrate into the Arctic Regions. The general distribution of the three families is as follows. The Typical Goatsuckers (Caprimulgidæ) are divisible into two sub-families. Of these the Caprimulginæ is by far the most cosmopolitan, having practically the range of the family, represented in every zoological region excepting New Zealand and the Eastern Pacific islands. The Nyctibiinæ is, however, restricted to the

Neotropical Region, where the species occupy only the tropical portions of that division. The Frogmouths (Podargidæ), a small family of Goatsuckers remarkable for their very large mouth, are an avine feature of the Australian Region, but some of the species are found over a considerable portion of the Oriental Region. The curious Oil Bird is the solitary member of the last of the three families (Steatornithidæ), and is confined to the northern portions of the Neotropical Region (from Peru to Guiana and Venezuela). The fourth sub-order is composed of the two very distinct families containing the Swifts and the Humming-Birds respectively. This sub-order is practically cosmopolitan, although one of the families is entirely confined to the New World, and the other is not represented in New Zealand. The Swifts (Cypselidæ) may justly rank as a cosmopolitan family, although they are not found in New Zealand. Three sub-families may be recognised. The first contains the Typical Swifts (Cypselinæ), which have nearly the same range as the family, except that they are not represented in the Pacific. The second contains the Spine-tailed Swifts (Chæturinæ), and is also a wide-ranging group, represented in each of the great zoological

regions, but absent from the western portions of the Palæarctic Region, from the extreme northern portions of the Nearctic Region, and the extreme southern portions of the Neotropical Region. Included in this sub-family are those Swifts, the nests of which furnish the famous bird-nest soup of the Celestial Empire. These birds form the genus Collocalia, and range from Madagascar across the Eastern Tropics to New Guinea and the Marquesas Islands. The third sub-family contains the Tree Swifts (Macropteryginæ), which are distributed over various parts of the Oriental Region, and in many of the Malay islands belonging to the Australian Region as far east as the Solomon group. The Humming-Birds (Trochilidæ) are confined to the New World, where, however, their range is an enormous one. These feathered gems—the loveliest of all avine forms—are certainly the most wonderful and remarkable feature of the bird-life of the New World; birds with no very close surviving relations, with absolutely no representatives or analogues in any other parts of the world, they stand alone and unique in the avine kingdom. But few species penetrate to the more extreme northern and southern limits of the group's area of dispersal, and even these are migratory, and

retire Equator-wards to winter. The great headquarters of the Trochilidæ are in the northern portions of the Neotropical Region, especially in Ecuador, in the mountainous areas of the Andes for about ten degrees north and south of the Equator. The lowlands are comparatively poor in species, and present the least metallic colouring. The Humming-Birds decrease in numbers farther south as we approach Chile and the Argentine, although the family is represented even as low as Cape Horn itself; whilst northwards, with the exception of the West Indies and Central America, where these birds are certainly plentiful, we find a rapid falling off in numbers, and but a single species penetrates as far as Alaska.

Our fifth sub-order is a remarkably small one, the Colii, composed of a single family, the Colies (Coliidæ). These peculiar little birds, bearing a superficial resemblance to a small Finch, with a very long tail and a conspicuous crest, are confined to the Ethiopian Region, but do not extend to Madagascar. There are some eight or nine species only. The sixth sub-order, the Trogones, is also a small one, and composed of a single family. The Trogons are a group of curious and bright-coloured birds confined to the

tropical forests of the Neotropical, Ethiopian, and Oriental Regions. One of the most remarkable of these birds is the Quezal (Pharomacrus mocinno) of Guatemala, in which the wings are overhung by lanceolate scapulars, and the tail more or less concealed by flowing rump plumes between three and four feet in length. The seventh sub-order, the Pici, is a composite and heterogeneous one, and includes no less than five families, each very distinct, and mostly of tropical or sub-tropical distribution. Taking these in the sequence given in the previous chapter (*conf.* p. 94), we have first the Jacamars (Galbulidæ). They are a small family of mostly metallic-plumaged birds confined to the Neotropical Region. Even here their range is comparatively a limited one, extending from Mexico in the north to Brazil in the south. None of the species appear to be found west of the Andes. The Puff Birds (Bucconidæ) come next, another small group of about fifty species, which, like the Jacamars, are confined to the Neotropical Region, ranging therein from Guatemala in the north to Argentina in the south, but most abundant in the great virgin forests near the Equator. Puff Birds occur west of the Andes, but are absent from the West Indies. The

Barbets and Honey Guides (Capitonidæ) follow, forming another tropical group, but of much more extended distribution, being found in the forest zone of the Equator round the world, with the exception of Australia. The Barbets are found in the Neotropical, Ethiopian, and Oriental Regions. They are divisible into two sub-families, viz., the Barbets (Capitoninæ), ranging through tropical America, Africa, and Asia, and the Honey Guides (Indicatorinæ), confined to the tropics of Africa and Asia only. The distribution of these birds is specially interesting. They are found in all parts of the Ethiopian Region, with the exception of Madagascar; whilst in Asia although found in the Himalayas they are otherwise absent from India, yet appearing again farther south and east on the mountains of the Malay Archipelago and Borneo. The next family consists of the Toucans (Rhamphastidæ), another most characteristic group of birds confined to the Neotropical Region. All the species are arboreal, and therefore confined to the forests, not only of the lowlands but up to an elevation of ten thousand feet. Their range extends as far northwards as Mexico (but does not include the West Indies, although one species reaches Trinidad) and as far southwards as Argentina.

Their headquarters are in the Amazonian and Guianan forests. The last family of the present sub-order contains the Woodpeckers and Wrynecks (Picidæ), subdivisible into two marked sub-families. The Woodpeckers (Picinæ) are a very widely distributed group, but curiously enough are absent from Madagascar and Egypt and the Australian Region. They are most abundant in the Neotropical and Oriental Region, although ranging over the entire Palæarctic and Nearctic Regions as far north as the limits of forest growth, and being fairly well represented in the Ethiopian Region. The Wrynecks (Iynginæ) are exclusively an Old World group. Of the four or five species our Common Wryneck (Iynx torquilla) has by far the most extensive range. Its summer range extends over the greater part of the Palæarctic Region, whilst in winter it includes most of the Oriental Region and the northern portion of the Ethiopian Region. The remaining species all belong to the latter region.

The Psittaciformes are essentially a tropical and sub-tropical order, Parrots only exceptionally being found in the temperate zones. They may be divided into six families. Parrots are most unequally distributed over their area of occupation.

The Palæarctic Region contains no representative of this group, whilst the Nearctic Region can only claim one, and that now confined to its more southern limits. The Neotropical Region is fairly well stocked with Parrots, one species penetrating as far south as the Strait of Magellan; but the Ethiopian and Oriental Regions are comparatively poor in species. The Australian Region is the metropolis of the Parrots, that portion of it extending from Celebes to the Solomon Islands being exceptionally rich in genera and species. It is in this region that the Parrots reach their most southerly known limits, the Macquarie Islands, in lat. 54° S.; whilst their northern range is most restricted in the Ethiopian Region, not reaching the Tropic of Cancer. The first family (Stringopidæ) contains but a single species, the curious Owl Parrot, confined to New Zealand. The second family (Psittacidæ) may be said almost to range over the distribution of the order, being represented in each zoological region. The third family, the Cocakatoos (Cacatuidæ), are a special feature of the Australian Region, although they do not extend into the Pacific beyond the Solomon group, and are not represented in New Zealand. The fourth family (Cyclopsittacidæ) are restricted to a small

portion of the Australian Region (from Timor to North-east Australia, and New Guinea). The fifth family, the Lories (Loriidæ), are essentially a group peculiar to the Australian Region. The sixth family, the Mountain Parrots (Nestoridæ), are confined to New Zealand.

The Cuculiformes are composed of two families, the Plantain-Eaters and the Cuckoos, the former of which is of restricted distribution, whilst the latter may be, broadly speaking, almost classed as cosmopolitan. The Plantain-Eaters (Musophagidæ) are confined to the Ethiopian Region, but they do not extend to Madagascar. The Cuckoos (Cuculidæ) are divisible into half-a-dozen sub-families, which are distributed as follows. The Typical Cuckoos (Cuculinæ) are almost exclusively an Old World group, where they are represented in all of the great zoological regions; a few species are found in the New World, where they range over the Nearctic and Neotropical Regions. The Coucals (Centropodinæ) are exclusively an Old World group, distributed over the Ethiopian Region, the Oriental and Australian Regions. The Couas and Rain Birds (Phœnicophainæ) have a somewhat peculiar distribution, being found in Madagascar, in the Indian Region, and in

various parts of the Neotropical Region. The Chaparral Cocks and allied birds (Neomorphinæ) are found in Sub-tropical North America, and in Borneo and Sumatra. The American Cuckoos forming the fifth sub-family (Diplopterinæ) range between Mexico, Ecuador, and Brazil. The Anis (Crotophaginæ) are also peculiar to the New World, ranging from the Southern United States over most parts of the Neotropical Region. Cuckoos are most abundant in the Oriental or Indian Region; whilst the complete isolation of the American species is significantly reflected in the exceptional number of peculiar genera.

With a brief glance at the distribution of the Passeriformes, we shall bring our review of avine dispersal to a close. As an order we may safely describe it as absolutely cosmopolitan. Its representatives are found in every clime from the ice-bound Arctic Regions to the torrid zone; there is scarcely an island that does not boast a Passere of some kind. As a group these birds dominate the earth; in the grand scheme of evolution the present era is particularly theirs. If, however, the present order is cosmopolitan, the various families that compose it are by no means so widely dispersed. Among the most cosmopolitan families may be mentioned the

Crows (Corvidæ), the Wagtails and Pipits (Motacillidæ), the Finches (Fringillidæ); but the latter have no Australian Region representatives; the Swallows (Hirundinidæ) and the Thrushes (Turdidæ). There are few parts of the world where these groups are not represented. Among the families of less general dispersal, yet represented in both the New and Old Worlds, we may instance the Dippers (Cinclidæ), the Wrens (Troglodytidæ), the Creepers (Certhiidæ), the Nuthatches (Sittidæ), the Titmice (Paridæ), the Shrikes (Laniidæ), the Waxwings (Ampelidæ) and the Larks (Alaudidæ), but the latter are very poorly represented in America. Among the Passerine families entirely confined to the Old World we may mention the heterogeneous assemblage of small birds, chiefly remarkable for their short rounded wings, of which the most typical are the Babbling Thrushes (Timeliidæ), the Hill Tits (Liotrichidæ), the Green Bulbuls (Phyllornithidæ), the Bulbuls (Pycnonotidæ), the Orioles (Oriolidæ), the Cuckoo Shrikes (Campephagidæ), the Drongo Shrikes (Dicruridæ), the Flycatchers (Muscicapidæ), the Birds of Paradise (Paradiseidæ), the Honey-suckers (Meliphagidæ), the Sun-Birds (Nectariniidæ), the Flower-peckers (Dicæidæ), the Weaver Finches (Ploceidæ), the

Starlings (Sturnidæ), the Swallow Shrikes (Artamidæ,) the Broadbills (Eurylæmidæ) (*conf.* p. 100), and the Pittas (Pittidæ). Most of these are tropical or south temperate families, the Bulbuls, Orioles, Flycatchers, Sun-Birds, Flower-peckers and Pittas alone encroaching upon the Palæarctic Region (which cannot claim a single peculiar family), and most of these do so to the very slightest degree, with the exception of the Flycatchers. Among the Passerine families entirely confined to the New World we may mention the Sugar Birds (Cœrebidæ), the Wood Warblers (Minotiltidæ), the Viereos or Greenlets (Vireonidæ), the Hang-nests (Icteridæ), the Tanagers (Tanagridæ), the Tyrant Birds (Tyrannidæ), the Manakins (Pipridæ), the Chatterers (Cotingidæ), the Wood Hewers (Dendrocolaptidæ), the Ant Thrushes (Formicariidæ), and the South American Wrens (Pteroptochidæ). We find precisely analogous phenomena of distribution in the New World as we found in the Old World. Not a single Passerine family is peculiar to the Nearctic Region; whilst such important groups as the Sugar Birds, Tanagers, Tyrant Shrikes, Manakins, Chatterers, Wood Hewers, Hang-nests, and Bush Shrikes are comparatively poorly represented

in that region, and mostly in the southern portions. These peculiarities of distribution emphasise the exceptional richness of the Neotropical Region in Passerine birds, for about a third of the whole number of species in the order are typically South American ones.

Of the most localised Passerine families we may instance the Hill Tits, confined to the Himalayan system; the Birds of Paradise, confined to New Guinea and the neighbouring islands and the north and east of Australia; the Honey-suckers, confined to the Australian Region; the Mamo (Drepanididæ) to the Sandwich Islands (conf. *Lost and Vanishing Birds*, p. 211); the Plant-cutters to temperate South America; the Lyre Birds to South and East Australia; the Scrub Birds (Atrichiidæ) to East and West Australia; and, lastly, the aberrant Pitta-like birds, of two species, forming the family Paictidæ or Philepittidæ, confined to Madagascar.

CHAPTER IV

THEIR MEANS OF DISPERSAL AND MIGRATIONS

The dispersal of birds—Fortuitous dispersal—Ancient land-surfaces—Polar dispersal—Equatorial dispersal—The law of dispersal — Obstacles to dispersal — Discontinuous areas of dispersal—Influence of climate upon species—Species increasing their range during present time—The migration of birds—Misconceptions concerning migration—Transmutation and hibernation—Migration and instinct—Migration not universal in certain species—The Cause of migration—Migration due to range expansion or colonisation—Cause of migration in autumn—Length of journey variable—The philosophy of migration—The wings of migrants—Moulting of migrants—Course of autumn migration—How birds find their way on migration—Migration across seas—General aspects of migration—Duration of migration — The speed of migration flight — The height at which migrating birds fly—The perils of migration—Lost birds at lighthouses—Various kinds of migration—Vertical migration—Local movements of birds—Nomadic migration—Irruptic movements.

THE two preceding chapters having dealt with the principal groups into which birds are divided by systematic ornithologists, and the various parts of the globe over which they are distributed, it becomes necessary now to

devote a chapter not only to the various influences which may be said to govern this dispersal of avine life over the globe as fixed and sedentary colonists, but as transitory visitors to certain areas, which are reached by what we term migration. The laws governing the Dispersal and Migration of birds are as yet but very little understood, and so long as naturalists believe that these facts are chiefly due to fortuitous agency, and are controlled by accidental circumstances, our knowledge is likely to remain very small, and our conception of the phenomena to be quite erroneous. It must also be understood that the Dispersal of birds and the Migration of birds are two very intimately related subjects; we cannot discuss or study one without the other; for as we have already repeatedly insisted, they are really correlative parts of the same phenomenon, the Dispersal of birds being the key by means of which we are enabled to solve not a few of the mysteries of Migration.

We will first then devote a few pages to the Dispersal of birds. How many readers might reasonably conclude that Birds, of all living things, would be the least likely to be confined to certain areas, and especially to restricted

ones. Birds are gifted with very exceptional means of locomotion; most species can fly; many can swim; so that the barriers that might confine or check terrestrial animals would, not a few readers may think, be utterly futile in arresting the colonising movements of such volant creatures. The facts, however, disclosed in the preceding chapter all tend to demonstrate that this is very far from being the case, and to suggest that many more or less perceptible influences are at work controlling the dispersal of birds over the globe. In the first place, if we admit that birds have sprung from a reptilian stock, as the details relating to their origin given in our first chapter appear incontestably to prove, and that the twelve thousand (in round numbers) known species now in existence were not each created in the places they at present occupy, then we must commence with the fact that all species in each genus (to go no farther back, this being sufficient to illustrate our contention, but the same principles apply to every family and order) have descended from a common ancestor which must at one time have been confined to a continuous area, from which its descendants have spread into other districts, where specific change has

arisen, aided by isolation and changed conditions of life. Now most naturalists believe that this subsequent dispersal has been entirely fortuitous, that species have spread this way and that over continuous land-surfaces or narrow seas (in the case of land birds); or, in the case of aquatic species, in whichever direction food may have been procurable. Many of those ancient land-surfaces, over which so many species are believed to have emigrated, have long since been replaced by water; as, for instance, between Asia and America, and between West Europe and Africa, or even between our own islands and Europe. Another great factor in the dispersal of birds over the globe is generally believed to be glacial epochs, which have driven numberless species from high latitudes into countries farther south. Hence the very generally prevailing belief in what is termed Polar Dispersal. In fact some authorities go so far as to say that Life originated first at the Poles and gradually spread towards the Equator. But there are many grave difficulties in the way of accepting such views, and we believe the evidence points to a diametrically opposite interpretation of the facts of dispersal, or in other words, that birds were originally evolved

in the equatorial region, whence they have spread in two grand streams north and south towards the Poles. This evidence is too complicated to be discussed in a popular little volume like the present, but the reader may consult the work on the migration of birds[1] by the present writer, where his theories of avine dispersal are fully elaborated. To our mind innumerable facts of dispersal suggest that species never emigrate or extend their area in the Northern Hemisphere *in a southerly direction*, nor do they so extend their range in the Southern Hemisphere *in a northerly direction*. Farther, there is no evidence to suggest that a species retires from adverse conditions (as the retreat from a glacial epoch), or that such have any influence whatever in expanding its geographical area of occupation. We believe that breeding conditions are the sole determining factor in such range expansion, and that a species extends its area as a natural result of increase. The soundness of these views is confirmed by many facts of geographical distribution and migration. Not only do we find many species absent from certain areas presenting few or no barriers to emigration save

[1] *The Migration of Birds.* Amended Edition, 1897.

the significant fact that to enter such areas a movement in a direction opposed to this suggested law of dispersal would have to be made; but we also find that, however remote the breeding grounds of a migratory species may be from the original centre of dispersal of that species (or one certain portion of it), it returns unerringly to that base, notwithstanding the fact that winter quarters are available by travelling in some cases less than one-third the distance. The distribution of our own Nightingale in England is an admirable example of the first-named fact, the absence of that bird from the south-west peninsula of England being, we believe, entirely due to that Law which forbids emigration or range expansion in the Northern Hemisphere to take a southern course; whilst such a species as the Arctic Willow Wren (Phylloscopus borealis), that actually breeds as far west as Finmark, but is not known to winter any nearer that country than Burma (the range base of the species), may be instanced as an equally admirable example of the second fact. It might be thought that such volant creatures as birds would not be deterred in their colonising or range-expanding movements by such obstacles as narrow seas—in not a few cases

dividing countries where the coast-lines of each are visible from either shore (as in parts of the English Channel, for instance), but such is not the case. Land birds everywhere evince a rooted objection to extend their area by crossing expanses of water, and a great many instances could be given where narrow seas which might be crossed in half-an-hour's easy flight have effectually arrested dispersal. But, on the other hand, we know that in not a few cases the range of a species is divided by such waterways. We have, for instance, the narrow seas that divide our islands from the continent of Europe and from each other, the Mediterranean, the Japan Sea, many parts of the China Sea, Behring Strait, Bass Strait, and so forth. Now, as we have already stated, land birds do not apparently ever increase their area over waterways—seas and straits—so that the natural inference in such cases of sea-divided areas of dispersal is that the birds must have entered those countries when no seas were barring the way. In not a few cases we know that at some comparatively recent geological epoch dry land actually did take the place of what is now shallow seas. This fact is further confirmed in another way. Wherever two countries are

divided by narrow shallow seas the avifauna of each is very similar in character—we find either the same species or others very closely allied to them in both. But in the case of seas of great antiquity—usually very deep—even though in not a few cases comparatively narrow, we often find that they separate avifaunæ of very different aspects. As examples of what we mean we may instance Madagascar, an island in which many families of birds commonly distributed over the African continent are entirely absent, and on the other hand, out of a number of less than 250 avine species more than 130 are peculiar to the island, many of which have no near African allies. The reader will also recall that in many cases mentioned in the previous chapter Madagascar is excepted from the Ethiopian range. Then we have New Zealand—another group of islands surrounded by ancient and deep seas—presenting us with a very similar series of facts. Or still more wonderful and suggestive, we may instance the case of two islands in the Malay Archipelago, Bali and Lombok, which are separated by a very narrow yet very deep and ancient sea. This strait is but fifteen miles across in its narrowest part, yet so effectual a barrier has it proved to

bird colonists that the avifauna of the two islands differs more than does that of Japan from Great Britain. As Wallace writes: "The birds of the one are extremely *unlike* those of the other, the difference being such as to strike even the most ordinary observer. Bali has red and green Woodpeckers, Barbets, Weaver-birds, and black-and-white Magpie-Robins, none of which are found in Lombok, where, however, we find screaming Cockatoos and Friar Birds, and the strange mound-building Megapodes, which are all equally unknown in Bali. Many of the Kingfishers, Crow-shrikes, and other birds, though of the same general form, are of very distinct species; and though a considerable number of birds are the same in both islands the difference is none the less remarkable, as proving that mere distance is one of the least important of the causes which have determined the likeness or unlikeness in the animals of different countries." The world contains many other similar contrasts.

But seas are not the only barriers to the colonising movements or dispersal of birds. Mountain ranges in not a few parts of the world have proved effectual obstacles to the range expansion of birds. In a similar manner deserts

have checked avine colonisation in certain directions. It must always be borne in mind that normal dispersal or extension of area is a result of numerical increase; as the individuals of any species multiply they seek out new quarters and occupy new districts. But the country that this surplus population invades must be suited to the requirements of the species that is gradually invading it. If a supply of food cannot be obtained, especially during the breeding season, if suitable nesting-places are absent, then the colonising movement cannot proceed in that direction. The special requirements of each species determine the general line of its emigration. Forest birds could not, and would not, attempt to increase their area across treeless plains; aquatic birds would only seek to do so in directions (always, however, conforming to the suggested law of dispersal already described) where suitable haunts presented; whilst birds that dwelt upon steppes and open country would follow such country only and colonise it. Then, again, mountain species would keep closely to the mountains in entering new areas of dispersal; coast birds could only follow the trend of the shore. Then in countless instances as a sedentary species has gradually spread from

a more or less equatorial base, all the early progenitors of that species may have from a variety of causes absolutely disappeared, and left their descendants as colonists in new countries far remote from their primal origin, without a trace being left to indicate the line of their dispersal. In some cases we can form a pretty accurate idea of the general route by the various allied and representative species which have established themselves nearer to the point of dispersal. With many migratory birds, however, the ancient centre of dispersal, or the range base from which the species commenced its colonising movement, is still returned to and used as a winter home. Here we may also state that the geographical area of nearly every species is continuous. Broken areas almost invariably lead to specific differences. There are one or two instances of apparently discontinued area (Asio capensis for example), the species remaining the same in each locality. But this may be due to a recent interruption, and eventually result in specific segregation should it remain permanent. Many species may possibly have originated on various islands as some large land mass became split up into an archipelago by volcanic or other action. As a rule, the more

remote the connection of an island with the adjoining continent the more diverse is the avifauna found upon it. Another fact of special interest to the student of geographical distribution is the enormous area occupied by some species, and the remarkably restricted one of others. The Barn Owl, for instance, is found nearly all over the world, whilst many other species of Owls are confined to a single island.

Finally, a few words concerning the influence of climate upon species. We may aptly repeat, almost word for word, what we wrote many years ago upon this matter: The importance of climate in zoological geography is considerable, although the subject has been much neglected by the student when seeking to solve perplexing questions of distribution. For instance, the Palæarctic Region presents some of the greatest contrasts of climate to be found in the world, and each particular kind of climate is stamped indelibly upon the plumage of the birds within its influence. The extreme west, including the British Islands and Scandinavia, is moist, favourable to the development of brown; the north and central districts, including Russia, Siberia, and Kamtschatka, are cold and dry, and here the colours are bleached and produce the arctic

forms, becoming the most pronounced in the latter country. In Japan the humidity returns, and much the same conditions prevail as in the extreme west; whilst in the dry, sandy districts of the south, pale desert forms are found; and in the extreme south the climate is suitable to the production of semi-tropical forms, where the colours reach their greatest intensity. The rainfall of a district is also stamped upon the plumage of birds, as is remarkably apparent, for instance, in examples of the same species from the wet or the dry districts of India respectively. This peculiarity may even be observed on a small scale in the British Islands, birds from the wettest districts generally being perceptibly darker in tint than those from localities where the rainfall is not so excessive. Birds from tropical regions where the maximum of humidity and warmth prevails have the greatest intensity of colour, browns and greys being perhaps the most susceptible. Olive browns are characteristic of a medium rainfall; rufous browns unfailingly reflect an excess of moisture. Dry, cold climates bleach; hot and dry climates have a tendency to produce paleness, becoming most pronounced in deserts.

We may also remark that some species are

known to be increasing their area of dispersal at the present time, or within the historic period. As a rule, and possibly because of the great stability or quiescence at the present time of those conditions that influence colonisation, but little expansion of area is now in progress. Among birds that are certainly adding to their area of occupation, or have recently done so, we may mention the Starling, the Rook, the House Sparrow, and the Partridge.

We will now pass on to a brief notice of the Migration of Birds. The coming and the going of these birds of passage appear from the very earliest periods of which we have any record to have made a great impression upon mankind. Jeremiah of old had evidently well studied the migration of birds, telling us that the Stork knows her appointed times, and how the Turtle Dove, the Crane, and the Swallow observe the time of their coming. The Prophet could not have selected better examples to illustrate his allusion, for the whole four species are migrants of the most pronounced type. Even savage man has not failed to remark the phenomenon, and to draw up his mental calendar punctuated by the dates of arrival and departure of the migrant birds.

There is certainly no other avine habit which

has been so much misunderstood or round which so much mystery, superstition, and wild theory has gathered as the migration of birds. Much of this has lingered almost to the present time, and even now there is not a little connected with avine season flight that still requires elucidation. We, have, however, divested the subject of some of its most incredible theories and speculations. No one now, for instance, believes that migratory birds seek a refuge in the moon during their absence from northern lands in winter; and yet this was almost regarded as a scientific fact a hundred and fifty years ago. There are still, however, some country people who will stoutly maintain that the Cuckoo undergoes transmutation in autumn, turning into a Hawk for the colder months. We have known one or two otherwise most intelligent game-keepers who thoroughly believed in this dual existence of the Cuckoo. Like many another legend it rests somewhat on fact, because our adult Cuckoo very closely resembles a Sparrow-Hawk, whilst the young one in its brown-barred plumage might very easily be mistaken for a Kestrel. Then there was the yet more widely prevailing belief that migrant birds — especially Swallows and Swifts — became dormant

at the approach of winter, and passed that season snugly hidden away in nooks and crannies, or buried in the mud at the bottom of pools of water. As most readers may know, Gilbert White believed in this hibernation habit, and not a few scientific men of distinction supported the theory. Possibly opinion nowadays may have gone too far in the opposite direction, and the general ridicule with which suggested hibernation among birds is received conceals the actual facts. We must remember that seasonal torpidity is a common practice among many animals and insects; that it is not a physical impossibility in birds, although there can be little doubt that if birds ever do sink into lethargic slumber the isolated instances must be exceedingly exceptional. There is some evidence to suggest that birds have been known to pass into this state. The testimony seems to be absolute and reliable. On the other hand the reader may rest assured that in no known species does hibernation generally take the place of migration. We have already dwelt at some length upon this question of avine hibernation in our book on the migration of birds, to which the reader may be referred.[1] Another equally

[1] *The Migration of Birds*, chap. ii., pp. 50–69.

absurd belief attributed to migratory birds was their presumed power to find their way from one country to another without experience or guidance. Young birds were believed to be hatched with an instinctive knowledge, not only of when to migrate, but how, quite irrespective of their more experienced parents. It is somewhat remarkable that even at the present day there are naturalists who believe in this mysterious faculty, and stubbornly assert in proof of it that the young birds migrate before their parents in many cases. This would certainly be very remarkable if it were true, but it is not, as we shall learn later on. Many erroneous opinions also still prevail concerning the speed at which birds migrate, the infallibility of the faculty of migration in birds, and the cause of the habit ; but these are questions that we may more aptly discuss in later pages.

In the first place, we may begin by saying that the habit of migration is by no means a universal one amongst all the individuals of many migratory species. The Robin, for instance, is practically a resident species in England, but those individuals that breed in Sweden and other northern lands are migratory, and travel even as far as Africa to winter. The Goldcrest is also a

resident in our Islands, but, as every ornithologist knows, vast numbers of migrant Goldcrests appear in them in autumn. The Hooded Crow is a resident in Scotland, but in many parts of the Continent it is a migrant, crossing the North Sea in vast hordes every autumn to winter with us. Similarly in the south we find certain migratory species, some individuals of which appear to be sedentary, such, for instance, as the Sedge Warbler, the Chiffchaff, and the Corncrake. Not only, however, is the habit of migration irregular, but the distance traversed is very variable among the individuals of a species, some journeying more than double the distance that others do. The breeding range of the Wheatear, for instance, extends from North Africa to Jan Mayen, whilst the winter or range base of this species extends to the Equator.

A few words now as to the Cause of migration. Perhaps the most popular opinion respecting this is, that the habit is due to failure of food. Migratory birds leave their winter quarters or base as summer comes on, and the requisite food begins to fail; whilst they quit their northern haunts as winter approaches, for a similar reason. Many naturalists of eminence are content to find the cause of migration in these suppositions.

Another, if less generally attributed cause, is the rise or fall of temperature. Other ornithologists believe that it had its origin in the accidental wanderings of birds, or even the aimless roaming of young birds in quest of food; whilst a very ingenious hypothesis attributes it not to want of food, but to want of light, during the several months of polar night in the Arctic Regions, ages ago, when those latitudes enjoyed a much warmer climate in winter than they do now. It will be noted that all these hypotheses on the cause of migration really mean a *retreat* from adverse conditions of life. Failure of food supply can scarcely be a tenable hypothesis, because, unfortunately, birds begin their migrations in numberless cases before food shows any sign of becoming scarce; neither can migration arise from accidental roaming, because birds, of all creatures, are closely attached to certain spots, and exhibit no propensity for straying beyond their normal limits, which are determined by other and perfectly well-known causes. After a long and close study of the facts, I am disposed to attribute the spring migration of birds to the range expansion or colonisation of a species gradually increasing the distance from its winter base. As we have already seen, the general trend

of this expansion is mostly polewards, but sometimes nearly due east or west. I attribute the autumn migration of birds to an overpowering impulse to return to the winter or range base, in which each individual and its descendants has some special spot, to which it is drawn by a variety of local causes. There are thus two points to which a migratory bird is attracted : its non-breeding centre, often an area associated with its gregarious instincts ; and its nesting-place, with the equal attraction of a mate. Most of us know how unerringly birds return season by season to their old breeding-places ; it may not be so widely known, still it is as much a fact, that birds return with as much certainty to certain spots in which they pass the winter. The breeding impulse may be said to be the primal factor in spring ; the social instinct, or an equally strong nostalgic impulse, a chief factor in autumn. The habit of returning in autumn, as soon as reproduction is accomplished and the moult safely over, to certain areas, appears to be as deeply rooted as the desire to return to other localities to breed in spring. The Impulse to return may be, and possibly is, inherited. But inheritance can go no further than this impulse ; the successful accomplishment of the journey depends upon

other factors. Young birds are not hatched with this hereditary knowledge, only with the inherited impulse to undertake the habit, as the many blunders committed by migrant birds in undertaking their annual journeys conclusively prove, which we shall learn later on. The wonderful amount of variation in the length of the migration journey, between the breeding-places on the one hand and the winter or home centres on the other, seems to me conclusively to prove that the habit of migration is purely and simply an acquired habit—one, in fact, that is subject to almost individual variation and exigencies. The migration journey when first initiated must have been insignificantly short, and only reached its present amazing length in many species gradually with the expansion, or even entire change, of the breeding area. As instances of birds with very short migration flights, we may name the Grey Phalarope and the various Eider Ducks; greater flights are presented by such birds as the Woodcock and the Rufous Warbler, with a length of from 1000 to 2000 miles; moderate flights by the Crane and the Lapwing, say from 3000 to 5000 miles; long flights by the Cuckoo and the Corncrake, say from 6000 to 7000 miles; whilst the most extended are presented by such species as

Swallows and Hudsonian Godwits, with a journey of from 7000 to 10,000 miles. These extreme limits, however, only represent the length of the migration of the *species*, not of the *individual*, for in many cases we have two sets of individuals of the same species, one set moving north, the other set moving south, from the equatorial centre of dispersal.

A few words now on what we may term the philosophy of migration. We have briefly dealt with what we believe to be the Cause of migration; now let us try and ascertain how and under what conditions the wondrous journey is accomplished. In a preceding chapter where we had the various bird groups under review, attention was repeatedly drawn to the fact that many families were remarkable for their long pointed wings. It is in such groups as these that we find the birds most remarkable for their migrations. Generally speaking, a bird must have wings adapted to quick and sustained flight to be able to migrate successfully; hence the rule is for birds of passage to be long winged and capable fliers. These long, powerful wings have been developed by successive generations of regular migration flight: the birds that fly most have the highest developed

apparatus for aerial movement; those that fly least the weakest; and in some cases, as we have already seen, disuse of the wings has eventually ended in loss of flight altogether. It is not a necessary corollary, however, that *all* long-winged birds are migrants. Many sedentary birds have long wings, but this is the result of having constantly to depend upon them to secure food: the Humming-Birds and many Birds of Prey are cases in point. It is most significant that the groups with the most rounded and concave wings are generally dwellers in warm regions, leading a sedentary life; in cold and temperate regions it is the exception to find a short weak-winged bird, the rule for them to have long and strong ones. Again, in order that migratory birds may be best able to undertake their periodical journeys, we find that they generally moult their plumage before they start. Once this tedious and dangerous process is over, migrating birds, which during its progress were sickly and skulking, brighten up, and each day only seems to increase the impulse to commence their annual passage. But migrants, as most observers know, do not all start off together; the ones that complete their moult earliest seem in many cases to be

the first to go, then late broods may delay others. So far as I have been able to ascertain, the general Order of migration is as follows. The first individuals of a species to migrate are birds that have lost their eggs or young, or from some cause have been prevented from breeding during the previous season. Following these are many young birds and their parents, the males in many species preponderating; then comes a rush of migrants, in which females may be the most abundant; whilst the rear is brought up by laggards kept behind from a variety of causes, such as damaged wings. The normal course of autumn migration, then, is for young birds to predominate in the earlier stages of the movement, adult birds towards the close. In spring this order is to some extent reversed. Then the adult males generally take absolute precedence, the old females travel next; the young of the previous season, the more or less immature individuals follow (in some cases these latter apparently spending the summer south of the breeding area), whilst, last of all, come the weakly and crippled.

The question now may naturally arise: How do birds find their way on migration across so many miles of land and sea? Here the greatest

mystery of Migration might be thought to come in. This portion of the subject at all events is surrounded by much unnecessary mystery, and agencies have been invoked, even by scientific naturalists, to account for this seeming wonderful power of birds to pass from place to place apparently unguided. Birds have been said to possess a mysterious sense of direction, an inherited but unconscious experience. Other naturalists have come to the conclusion that birds possess an inner magnetic sense, by which they are not only guided but able to ascertain their position in relation to the magnetic poles. The performance of the Homing or Carrier Pigeon has been brought forward to prove that birds possess an inherited sense of direction. But the facts of the case, instead of supporting the assertion, directly refute it. These Pigeons have to undergo a careful course of training before they are able to fly from one distant place to another; that is to say, they have to be taught the way in a series of stages until they have learnt the topography of the route. If this be obscured by fog the birds will not attempt the task, or doing so soon lose their way. They fly by sight, aided by a very retentive memory for certain landmarks. Another

naturalist suggested that birds found their way across seas by noticing the peculiar roll of the waves; but these are constantly varying in direction, especially in narrow land-locked seas which are crossed by migrants, according to the influence of ever-changing winds. The reader may perfectly well rest assured that all this theorising is profound nonsense. The theory of instinct may be very pretty and very attractive, but it is not supported by logic or by facts. Birds migrate purely and simply by an exercise of those extremely acute powers of observation and keen aptitude for recognising landmarks, the result of an intensely receptive memory, the result of experience, and coupled with a great knowledge of locality. But these powers, great as they undoubtedly are, would be useless along a strange road, so that birds individually keep close to certain routes, these latter having been gradually formed as the range has spread out from the original centre of dispersal. Little by little during the history of the species has the journey become longer as the breeding-places became more and more distant from the winter range base. The road is so familiar even to those individuals that breed the farthest from the winter base that

they are able, given favourable meteorological conditions, to perform the journey with the utmost confidence, and even in a single, more or less uninterrupted, flight. The habit of migrating across seas was acquired when those areas were dry land. There are few (we doubt if there are any) or no instances of migration across deep and ancient waterways; the sea has gradually replaced the land as the habit of migrating across the area was formed. Not only so; at the great altitude at which birds migrate there are few if any waterways that cannot be spanned by the eye of a bird migrating over them, one coast-line coming into view as soon as, or even before, the other is lost. We may here state that some writers have asserted that certain birds reach their breeding-grounds by one route and return to their winter quarters by another, but there is not a shred of reliable evidence to support the contention. If such were the case migration would then reach to a degree of mystery that even the wildest theory has yet failed to carry it.

The general aspects of Migration are full of absorbing interest. Some birds appear to travel exclusively by day, others as habitually by night, others yet again both by day and night. The

great majority of birds appear, however, to prefer the latter time. Then the punctuality of their arrival in certain spots season after season is most remarkable. Almost to the day, nay almost to the hour, we may confidently look for certain migratory birds to arrive, and seldom are we disappointed. The Swifts leave my Devonshire home each year almost to the day; they arrive with almost the same punctuality. Some sea-birds visit their breeding-places with equal punctuality. The sociability or the reverse of migrant birds is also interesting. Some birds migrate in a solitary way, eschewing the company of their kindred, so far as we can see; others always congregate for the annual journey. Generally speaking, however, gregarious tendencies are a characteristic feature of migration both in spring and autumn, but more especially so at the latter season. Social tendencies are also common during migration, and it is no uncommon thing to see a large flock of travelling birds composed of several species. Again, an odd bird or so of one species will not unfrequently attach itself to a flock of migrants, perhaps of very distantly allied birds, and journey in their company. Then there are not a few life-paired species in which the spring journey

especially is undertaken by the sexes in company, male and female arriving together.

The duration of the migration of each species is from one to two months at each season, having regular phases of intensity. In some few species the flight continues over a much longer time. First the migration of a species is marked by the arrival or departure of a few stragglers, the most restless individuals; then the migration of that species becomes more pronounced, until its period of greatest strength is reached, possibly marked by one or two great "rushes," or extraordinary numbers of individuals; after which it gradually dies away similarly as it commenced. These phases of intensity are more characteristic of some species than others. The whole period that a migration of any one species lasts, however, is not occupied by absolute flight. The time is taken up in gradually draining the summer or winter area, and is of course shorter in the species with a small distribution than it is in those occupying a vast tract of country. In some cases the breeding area of a species occupies more than three thousand miles of latitude, with a consequently great variation of climate and date of season; then it will be prolonged over several months at least, the individuals

breeding in the most northern portions leaving them, it may be, six or eight weeks before the individuals breeding in the southern portions (and necessarily much nearer to the winter base) do so. We may thus lay it down as a rule, that where the breeding or winter area is narrow, the migration is short, and *vice versa.* When absolutely migrating, birds do not appear to travel direct from the point of departure to their destination; rather do they travel by stages, and in a more or less leisurely way, feeding and resting here and there *en route.* This is especially the case in autumn; spring migration always appears to be more rapid. The quickest part of the whole journey may possibly be that over the sea; but in many cases migrant birds have no sea to cross at all. The actual speed at which birds fly when migrating is very difficult to ascertain. Some perfectly astounding statements have been made concerning this matter, but the reader is cautioned against accepting them. That some birds can fly very fast we know is unquestionable; but that they habitually do so when migrating is not supported by facts. It has been said that certain species pass from Africa to Central Europe at the astonishing speed of four miles per minute for the whole

of the way without a pause or rest! What we do know respecting the flight of birds, and especially a long-sustained flight, is quite contrary to these wonderful estimates. The Homing Pigeon record for several successive hours is, we believe, under sixty miles per hour; but, aided by a gale, a speed of 2150 yards per minute has been reached. When we come to the relative speed of migration, however, we are on much surer ground. The Baltimore Oriole, by a very careful series of observations, has been found to travel at the rate of twenty-seven miles per day; the record of fifty-eight species gave an average of twenty-three miles per day. The records also tend to show that the smaller land birds do not perform long journeys over land at one time. King Birds have been estimated to do forty miles in a single night, but, exceptionally, as many as 100 or even 200 miles in the same period of time. At present, however, there is absolutely no reliable data upon which to speculate. The height at which migrating birds fly is also very interesting. Without ascending to a considerable altitude the migrations of many birds would be simply impossible. Most birds appear to fly high during migration. Birds have been often observed on passage flying at a height of from one to two

miles; Cranes have been detected passing across the sun's disc at an estimated altitude of five and three-quarter miles! These latter birds, we may mention, have been observed crossing the vast Central Asian mountains at great elevations above them. The most important benefit derived from such a lofty course is the increased range of vision that it ensures. The higher a bird flies the farther it can see, the more extended becomes the visible segment of the earth's sphere below it. From such lofty courses the earth and sea spread out like a vast panorama below the migrating bird, charged with a full knowledge of the topography of its accustomed route; all the old familiar landmarks are recognised as the wondrous journey is performed.

But all this is the brighter aspect of the migration flight. Very often fogs and rain mists obscure the land, and storms overtake these feathered pilgrims, bringing disaster and death. At such times during spring and autumn (the latter season more especially, because then the migrants are more numerous) scenes of rare wonder are often witnessed at the lighthouses and light-vessels on coasts frequented by migrant birds. The poor lost little pilgrims are attracted to the lanterns very often in tens of thousands,

where they flutter to and fro, or drift by in an aimless manner utterly bewildered, or strike against the glass with such force as to kill themselves. Large numbers are known to perish in this manner every season. It is only on overcast nights, however, that such scenes are witnessed, and even then as soon as the heavens become clear the migrants disappear like magic, passing on their way again. Many birds also lose their way when on migration, especially in autumn. A very large percentage of these lost birds are young ones. This fact in itself should at once do away with any theory of instinct, for instinct must be held to be infallible. The various cries uttered by birds when on migration are also very interesting. These cries are uttered most probably to keep the members of the flock together as they fly across the night sky, and often sound singularly weird and imposing from the darkened air. It is also somewhat remarkable that the noisy birds are those that chiefly migrate by night: birds that travel by day generally do so in silence.

In conclusion, we ought also to allude to the various kinds of migration that birds undertake. The best known type of migration is that of which the Swallow, for instance, is a good

example. This means a journey from some southern land to a northern one for the summer, and a return to the winter home in autumn. Then we have what is termed Vertical Migration, in which certain birds leave the lowlands and plains in spring, and seek summer quarters high up the mountains, it may be (and mostly is) without leaving a country or crossing the sea at all. This kind of migration is very prevalent in warm countries. Indeed some few British species—birds that visit us in summer—are vertical migrants in more southerly localities, finding suitable summer quarters by elevation rather than by latitude. Then we may briefly allude to the various local movements of birds, usually undertaken during the non-breeding season. These can scarcely be classed with regular migration, because they are without any apparent system or method, prompted solely by a desire for food, and in all cases take place within the normal area of dispersal of the species engaging in them. The most pronounced kind of local movement may be classed as Nomadic Migration, usually prevailing among birds that live in cold regions, and which are wandering about almost all the year except when engaged in rearing their young. Within certain

well-defined limits these birds appear to have no settled home. Lastly, we may allude to the Irruptic Movements of birds. These cannot be classed either with normal migration or nomadic migration. They are entirely abnormal movements, only occurring at irregular intervals, and caused by an exceptional excess of individuals breaking forth from congested districts, spreading far and wide, yet never succeeding in colonising new areas. One of the most remarkable instances of this irruptic movement is furnished by that curious bird known as Pallas's Sand-Grouse. Readers may recall its visits to Western Europe and the British Islands a decade ago—an irruptic wave of birds that spread from Central Asia. Similar irruptic waves of Jays and Goldcrests have also been remarked.

CHAPTER V

THE GENERAL HABITS AND FUNCTIONS OF BIRDS

The flight of birds—Flightless birds—The fitness of birds for an aerial existence—Various modes of flight—Gliding flight: how performed—Flight by active strokes of the wings: how performed—The movement of the wings—Soaring or sailing flight: how performed—Terrestrial and aquatic motion of birds—Birds unable to progress upon the ground—Running, walking, and hopping movements—Progress in water—The food of birds—Modifications of the bill—Common to various distantly related groups—Social, gregarious, or solitary instincts of birds—Mimicry in birds—Protective colours and resemblances of birds—Forest birds—Desert birds—Marsh and swamp birds—Moorland and mountain birds—Arctic birds—Variation in birds—Of external structure and colour—Dimorphism in birds—Sexual dimorphism — Dimorphism independent of sex — Structural dimorphism.

We have now reached that stage in the story of the Birds where it becomes necessary to devote a chapter to their general Habits and Functions. We have traced their history from their early origin down to the present era, and briefly sketched their general characteristics, anatomical and otherwise; we have grouped all living birds

into fairly natural orders; traced the distribution of birds over the world, and then discussed the laws of their dispersal and migration. The most characteristic habits and functions of Birds may now fittingly help their story onwards.

Of course it would be quite impossible to give even the barest *résumé* of the habits, infinite in variety, of nearly twelve thousand species of birds. On the other hand we may, at least, be successful in describing some of the more characteristic habits possessed by most birds in common, together with a few of the more remarkable peculiarities of the class. These naturally group themselves into various classes of phenomena, among which we may mention Flight, Terrestrial and Aquatic Motion, Social, Gregarious, or Solitary Instincts, Food and the many methods of procuring it, Mimicry, Protective Colours and Resemblances, and, lastly, the very difficult problems of Variation and Dimorphism.

We will first devote a short space to that function of the wings termed Flight, together with certain aerial habits of birds. Flight may be said to be nearly universal among birds; it is one of their most remarkable characteristics, their name being almost synonymous with an aerial existence. There are, comparatively speaking, very few

birds indeed that cannot fly, and in all cases to the contrary the wings have reached their present degraded and functionless state through disuse. It is almost a demonstrable fact that the earliest bird forms could fly, and that all flightless birds, no matter how archaic their type (such as the Ratitæ), have been brought to that condition by the neglect of their ancestors to make proper use of their wings. Birds, then, are the only vertebrate animals that can fly, with the sole exception of bats, and in their case the analogy is scarcely a perfect one.

It requires but a very elementary knowledge of the anatomy of birds to convince us that these creatures are in every way fitted for an aerial existence. Not only is the general shape of the body one best adapted for easy cleavage of the air, but the bones being hollow, are exceptionally light, whilst the extraordinary lightness of their dermal covering has passed into a proverb, "As light as a feather." Then again, as we have already seen, the anterior limbs of a bird are attached to the highest part of the body, whilst all the least weighty organs are similarly situated. The heavy pectoral muscles and the stomach being in the lowest part of the body renders the centre of gravity as advantageous as possible beneath the suspension centre of the wings. Then,

many birds of exceptional flight endurance are rendered even more buoyant by the presence of curiously modified pneumatic skin, as well as various air sacs. Vultures, Gannets, and Screamers may be instanced, although it is only fair to state that some anatomists suggest that the principal function of these air sacs is to ventilate the lungs, which in birds are only capable of comparatively limited movement. Even in this case, however, their correlation with flight is obvious. Professor Roy (who contributes a most interesting article on Flight to Professor Newton's *Dictionary of Birds*, to which we are indebted for many of the following particulars) divides avine Flight into three distinct classes. According to this authority, then, Flight may be performed, firstly, by gliding or skimming; secondly, by active strokes of the wings; and, thirdly, by sailing or soaring. In the first place, we must remember that the relation of the wing area to the weight of the bird varies considerably, and that the greater the former relatively is the more powerful the flight will be. An equally large amount of variation exists in the strength of the wing muscles, this corresponding with their weight. Then, as we have already seen, the shape of the wing is equally subject to much variation, and is largely

correlated with the general habits of the bird. Gliding Flight is classed by Professor Roy as the simplest. An example of this in its commonest form is presented when a bird, having reached a certain velocity by rapid wing-beats, extends them and expands its tail, and skims forward for some distance. Sometimes the necessary speed for the performance of this kind of flight is attained by descending from some eminence. This movement cannot last very long, because it is made either at a loss of vertical height, or continued forward movement. The direction, however, may be upwards or downwards, in the former illustrated by the swoop of a Falcon with closed wings to the ground, the momentum thus gained being sufficient to send the bird gliding upwards again on extended wings. Most observers must often have been impressed by the consummate ease with which a gliding bird can guide its motion, but how this is done is not at all generally known. Any increase of velocity tends to push upwards the anterior part of a gliding bird's wing, and cause the bird to rise higher in the air. But this a bird can prevent in various ways, either by changing the position of its centre of gravity forwards by extending its neck (in a long-necked bird like a Crane or a Heron), or

backwards, by retracting it, or (in a short-necked bird) by moving forwards or backwards the extended wings, or opening or closing the tail. Change of direction upwards or downwards can thus be obtained by moving backwards or forwards the centre of gravity, and this without changing the angle of the under surface of the wings and tail with the general direction of the flight. All this involves but little muscular exertion, and a similarly small amount of energy. A turn to the right or left is made by changing the centre of gravity to one or the other side of its centre of suspension by the expanded wings, either by a turn of the head, the course following the same direction, by partly bending one wing, or raising one side of the expanded tail, which also causes a turn in the same direction.

Flight by active strokes of the wings is the most ordinary method adopted by birds in passing from place to place. As Professor Roy points out, it is much easier for a bird to sustain itself in the air by active flight, if it have a certain initial relative velocity, than when it begins to fly from a point of relative rest. Most large birds, especially, therefore seek to rise from the ground with their heads to wind. In the absence of wind (and in some species this condition is immaterial)

these birds gain an initial velocity by running for some distance, or, in the case of aquatic birds, by striking the water with the tips of their wings for the first few strokes. Smaller birds gain an initial velocity by a spring, and this fact explains why so many short-legged birds rise with difficulty from a flat surface, or, in some cases, are unable to do so at all. That kind of active flight known as "hovering" (of which the Kestrel is such an excellent and familiar example) can only be indulged in by birds of very powerful flight, great exertion being apparent in the frequency with which the wing strokes succeed each other. As a rule, the wings are moved quickest as the flight commences, the angle through which the pinions move being a large one, in some cases the wings striking each other above the back at the end of the up-stroke, and the tips nearly meeting at the end of the down-stroke. This may often be remarked in the Ring-Dove, the noise made by the wings striking each other being considerable. As the flight becomes quicker the wing-beats become slower, and the angle made by the wings is much smaller. We are indebted to instantaneous photography for a clear demonstration of how the wings of a bird are moved during flight. The wings, or rather

we should say the upper arm-bone or humerus, moves in an elliptical direction during the down-stroke (which takes a longer time to make than the up-stroke), which describes the front half of the ellipse, the wings moving forward as well as downward. Having made this stroke, the wing moves backwards and upwards, describing the posterior half of the ellipse, and the plane of the wing is altered, so that it looks down and forward. During somewhat rapid flight the up-stroke is chiefly a passive movement, the bird continuing to rest on the wings, the velocity of the body slightly decreasing, but recovering speed again with the next down-stroke. Just as flight commences, however, the up-stroke is an active one, and the long quills in the wing separate from each other, thus reducing the air resistance to the back of the wing as it travels upwards.

Soaring or sailing flight is much the rarest form of aerial motion indulged in by birds. It primarily differs from gliding flight, in the fact that the bird practising it does not of necessity lose vertical position or velocity as a result of atmospheric resistance. The birds in which soaring or sailing flight is most typical are Vultures, Falcons (notably Eagles), Frigate

Birds, Gannets, and so forth. These aerial soarers are mostly big birds, with an extensive wing or sail area in proportion to their total weight. More or less wind appears to be absolutely essential to this mode of flight, and one of its most marked characteristics is the curved or circular course which it describes. Various theories have been propounded to explain how these soaring flights are performed, but as yet their explanation is by no means complete or satisfactory. They have been attributed to upward currents of air, as well as to the varying velocity of the wind at different heights above the earth. By whatever means they are performed they are wonderful exhibitions of volant force; and the observer may well be profoundly impressed as he watches the soaring flight of Vulture or Eagle high up in the blue sky, conducted, as it were, with no visible effort.

From the aerial progress of birds we will now turn to a brief notice of their terrestrial and aquatic motion. There is probably a greater amount of variation in the latter methods of progress than there is in aerial locomotion. There are, for instance, far more birds unable to walk than there are unable to fly. It is, as we know, very exceptional to find birds

incapable of flight, for functional wings are very essential to the existence of most species. On the other hand, there are large groups of highly specialised birds that are unable to progress along the ground with their legs and feet. We may instance the Humming-Birds and the Swifts, numbering together many hundreds of species, also the Swallows, although the latter birds are perhaps not quite so helpless in this respect. Humming-Birds and Swifts never normally visit the ground; Swallows often do so, however, but they rarely attempt to make any progress there, and never unless aided by their wings. As we know, these birds find an abundant compensation for their loss of terrestrial motion in their remarkable volant powers. They may be said to pass most of their existence in the air, where legs would be a superfluity. Their anterior limbs have developed at the expense of their posterior ones. Then again we find many species of birds that walk with difficulty or with a ludicrous amount of awkwardness. Among these we may mention such species as Divers, Auks, Grebes, Penguins, Frigate Birds, Pigeons, and Ducks. Some of these possess great powers of wing (Frigate Birds), but the majority, although very capable fliers, find their

legs of the greatest service as aids to swimming and diving. These are placed so far back as to render walking by no means easy or elegant in the purely aquatic species; but their adaptiveness to an aquatic existence is beyond criticism. Their legs and feet are used as oars, modified in various ways so that they may combine the greatest power of propulsion in the backward movement or stroke with the least degree of resistance in the forward one. Many of these birds (Divers for instance) are said to assume a ventropodal position when on land, never standing in an upright attitude; but that this is not invariably the case my own and others observations prove beyond doubt.

The usual modes of progress on land by birds is either by running, walking, or hopping. We cannot say that either mode of progression is peculiar to certain groups, or in many cases to certain species, but generally speaking these various methods of moving about are characteristic of the following birds respectively. All the Ratitæ birds both walk and run, when the latter, usually balancing themselves with their short wings. Amongst Carinatæ birds the typical walkers, as they certainly are the most stately, are Cranes, Herons, Storks, Flamingoes, Bustards,

and so forth. The Rails, too, are very elegant in their carriage ; so, too, are the Gulls ; but the Terns, owing to their comparatively short metatarsi, are but indifferent walkers. Game birds both walk and run, as also do many of the Plovers and Snipes; but running is an especial feature in the progress of the Charadriiforme birds on land. Incidentally we may remark that we once saw a Ringed Plover, when standing upon one leg on the sands, hop for several yards rather than put the other leg to the ground. Pigeons are but poor walkers or runners, owing to the short metatarsi ; so, too, are Sand-Grouse ; and even more especially Goatsuckers, and many of the Cuckoos. Amongst the swiftest bird runners we may include some of the Rails. The long-legged Geese are fair walkers, but the shorter-legged Ducks are awkward and waddling in their gait. Parrots, again, are clumsy walkers, although they are agile enough in trees, where they climb about the branches assisted by both bill and feet. Many of the Kingfishers are practically incapable of terrestrial progress. Amongst Passerine birds we have examples of each mode of progression ; in fact some species employ all, as fancy or circumstances may decide. Crows,

for instance, both walk and hop; Thrushes not only walk and hop, but occasionally run as well. We often find considerable difference in the gait of very closely allied birds. A Chaffinch not only runs, walks and hops, but a Sparrow invariably progresses by the latter means alone. The most expert runners amongst the Passeres are the Wagtails, Pipits, and Larks. A hopping gait is certainly the most prevalent amongst small Passerine birds. Woodpeckers, when they do visit the ground, which in some species at all events is much more frequently than is generally supposed, progress in long hops; but on the trunks of trees they run and walk only, supported by the stiff tail. The Passerine Creepers progress in a similar way. We may conclude this portion of the subject by a brief allusion to the various actions of aquatic birds. We pass over the plunging of Gannets and Terns and other species, for that scarcely comes within the scope of the present subject, being connected with flight. Aquatic birds, then, may either swim or dive. The birds that dive of course can swim equally well, but there are many birds that swim yet never dive. Even amongst the Ducks we have two special groups; one distinguished for diving, the other for

swimming only. This aquatic progress is usually associated with webbed or lobbed feet, but some species are equally expert at swimming and diving with no such appliances. The Water-Hens furnish us with a capital instance of this. Another very curious habit of certain aquatic birds (notably Divers and Grebes) is that of gradually sinking the body into the water until all but the beak or the head is submerged. Lastly, we may mention the peculiar motions of certain Petrels, these birds frequently running, as it were, over the smooth surface of the ocean waves, pattering the water with their webbed feet.

Now a few words concerning the Food of Birds and the various methods of obtaining it. Our study of the structure of birds has already suggested the great variation in the food which must prevail among the many thousands of species. The diverse way of obtaining it, the immense amount of modification in the structure of the bill and feet, to say nothing of the internal organs of digestion, are none the less interesting. Generally speaking, the bill of a bird is a sure indication of the general food of a species, whilst the feet and wings suggest to some extent the method of securing it. The

long pointed wings, the weak feet, and the wide gape of the Swallow all indicate an insect diet secured whilst the bird is coursing about the air. The equally long wings, in combination with the powerful feet with their sharp claws, and the strong hooked and toothed bill of the Falcon, tell us as plainly as spoken words could do that this bird is a hunter of living creatures—that it preys upon flesh. The chisel-shaped bill of the Woodpecker, with the curiously modified tongue, the zygodactyle feet, and the stiff-pointed tail, betray the bird's partiality for insect food and the peculiar methods of obtaining it.

The modification of the bill in some groups is very much more extensive than in others. A diverse amount of modification in the bill seems correlated with a high degree of organisation, and its consequent variety of habit and food. Thus we should expect to find, and really do find, the greatest amount of variation in the bill amongst the most highly-organised group of birds, the Passeriformes. Here we cannot say that any shape of bill is typical, no more than we can assert that any one kind of food is common to the group of the insectivorous Passeres—such as Warblers,

Thrushes, Wrens, Vireos, and Bulbuls—we find bills adapted not only for picking up insects, but for seizing worms, grubs, and so forth; then as we come to the more specially insectivorous forms we find a widening of the bill and a greater development of rictal bristles, as in the Flycatchers; whilst in the exclusively insectivorous feeders the bill itself becomes small and weak and the gape exceptionally wide, as in the Swallows. Another change of food is unerringly indicated as we reach the Titmice and Nuthatches, the bill now being perceptibly and relatively stouter, and adapted for digging into wood and other hard substances in quest of grubs, nuts, and so on; whilst still greater strength and a perceptible hook and notch characterise the bill of the Shrikes, which seize large case-protected insects, small birds and mammals. Then we revert to the finer-shaped bills again as we reach the insectivorous Wagtails, for instance, whilst a more slender and longer bill again is presented by the Sun-Birds, many of which have this organ specially modified in shape and length to reach insects, and possibly nectar, in certain flowers. Another change of food introduces us to yet another type of bill. With

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the Larks we come to the graminivorous section of the Passeriformes, and the stouter bill plainly indicates that hard seeds as well as insects are sought. As we approach a more exclusive seed diet the bill as surely becomes modified to cope with it. The Buntings have the palate furnished with a hard, bony knob, and the bill modified to fit it, which enables these birds to crush and shell hard seeds with the greatest precision. The Finches also have a hard bill more or less similarly modified for the purpose of cracking seeds; whilst the hard, strong conical beak of the Crows is well adapted to the almost omnivorous diet of those birds. One of the most remarkable modifications of the bill in this group is presented by a New Zealand species, the Huia, scientifically called Heteralocha acutirostris. In the male of this species the bill is short, stout pointed, and nearly straight, whilst in the female it is long and curved almost like a sickle. Now the favourite food of this bird is the grub of a certain timber-boring beetle. To obtain this the bill of both sexes is brought into use. The male with his short strong bill digs away as much of the wood as possible that conceals the grub, then the female with her long slender

bill comes and drags it out. When not feeding in company the male digs his prey out of the decayed wood, whilst the female probes the nooks and crevices for hers. This peculiarity is an example of what is called sexual dimorphism, a phenomenon of which we shall say more presently.

It is a somewhat remarkable fact that very similar modifications of the bill are found in distantly related groups of birds where the same kind of food is sought. There is, for instance, a very strong resemblance between the bills of the Divers, Grebes, Herons, and Storks—all possessing beaks more or less spear-shaped, and adapted most beautifully to seizing slippery fish. But, on the other hand, we also find extraordinary divergence in the shape of the beak in some members of the same order. What, for instance, could be more unlike than the sharp spear-like bill of the Heron and the flat spoon-shaped beak of the Spoonbill? Different food, or different methods of securing it, explain the curious variation; for one bird stands by the water-side and transfixes the fish as they swim unsuspectingly by, whilst the other sifts the mud and water, moving the flat bill from side to side in a half circle. The

bill in the Charadriiformes also presents considerable diversity in harmony with special kinds of food and peculiar methods of obtaining it; in the Lariformes, however, there is much greater uniformity, because these birds all feed upon fish and similar prey. The Terns, however, have the bill modified to seize their prey by a plunge, whilst the type of bill is most emphasised in the Skuas, which are, as we have already seen, notorious robbers of the food from the Gulls. Another group in which the food is very uniform in character is the Parrots, and as a consequence we do not find much radical modification in the bill, that organ being adapted to crush nuts, fruits, and so on.

We may now pass on to a brief notice of the social, gregarious, or solitary instincts of Birds. Even the most casual observer of birds cannot fail to remark that these creatures vary a good deal in their social instincts, either throughout the year or more particularly at certain seasons. As we find examples of each of these instincts in almost every great group, no general rule can well be laid down respecting them. Perhaps the most widely prevailing of these instincts is the social one. This may be partial; that is to

say, it may only be displayed at certain times or seasons, or it may be permanent in its prevalence. When the social or gregarious instinct is only a partial one it is generally displayed after the breeding season is over, when the broods and their parents join others and form into flocks which pass the autumn and winter in company. Less generally, however, we find these conditions absolutely reversed, certain birds becoming gregarious at the approach of the nesting season; yet when the young are reared the gatherings disperse, and more or less solitary instincts prevail until the return of another breeding time. On the other hand, there are many species that remain gregarious throughout the year, always breeding in societies, and continuing in company when sexual duties are over. Many birds individually manifest a social instinct, not always a desire for the company of their own kind, but an inclination to mix with a flock of some other species. It may be that these socially inclined birds have no opportunity for the time being to join gatherings of their own species, and gratify a gregarious yearning in the only manner available. Lastly, we have the recluses, birds that remain in a more or less solitary state

always, save in the season of reproduction. Some of the most solitary of these are the Eagles and other Raptorial Birds. It is also worthy of remark in connection with this peculiar instinct, that some birds allow their broods to keep in company with them almost up to the time of the next breeding season; but others invariably disperse their family as soon as the nestlings are able to forage for themselves. In a great many cases the brood and parents migrate in company; in fact, gregarious and social tendencies are exceptionally characteristic of migratory species. A plausible explanation of these social and gregarious instincts in birds may be that a greater amount of safety is ensured by flocking together; and this seems confirmed by the fact that the most solitary birds are either of large size or predaceous habits—birds well able to take care of themselves.

We will now pass on to a brief consideration of Mimicry, Protective Colours, and Resemblances amongst Birds. These are subjects which an entire volume would not be sufficient to exhaust; all that we can do is to give a few of the most interesting facts. Take the subject of Mimicry first, a fascinating study truly, and

one concerning which but comparatively little is known. For our present purpose we cannot do better than give the general substance of what we have already written in a volume to which the present may aptly serve as a supplement.[1] Of all forms of protective modification of plumage that of Mimicry—a weak and defenceless bird imitating the colour of a stronger and more favoured one—is certainly the most curious and remarkable. Two facts, however, must be kept in mind; the first, that this resemblance between distantly related species is apparently unconscious on the part of the species practising it; the second, that all instances of similarity of colour in different species are not necessarily cases of Mimicry. These must fulfil certain conditions, admirably laid down by Dr. Wallace, as follows. The imitative species must inhabit precisely the same localities, the imitators must be the more defenceless or labour under some other disadvantage, be least numerous individually, and present marked differences from the majority of their allies. In every true case of mimicry the points of imitation are external and visible only. Some of the most interesting instances of avine

[1] *Curiosities of Bird Life*, pp. 235–241.

mimicry are presented by the Cuckoos. Not only do certain species of these birds very closely resemble Hawks, but others bear a remarkable likeness to certain Game Birds. Our own Cuckoo resembles the Sparrow-hawk so closely that even small birds are apparently deceived, as seems confirmed by their chasing it, just as they often mob the rapacious bird. Then the young Cuckoo in its turn bears a very remarkable likeness to the Kestrel; and this may possibly be an advantage to it, for the small foster-parents of the Cuckoo do not fear the Kestrel; whereas if it resembled the Sparrow-hawk at this age, they might easily become alarmed at its Hawk-like appearance, and desert it long before it was able to take care of itself. The resemblance to the Kestrel must doubtless be a further advantage to the young Cuckoo by often saving it from the attacks of predatory birds and beasts. Then other species of Cuckoo that resemble Game Birds derive an advantage from the fact that the latter are strong, pugnacious species, living in companies, and usually accompanied by bellicose males ready to attack and beat off marauding birds and animals. Other Cuckoos again resemble certain pugnacious Drongo Shrikes, inhabiting the same

districts. Other and even more interesting cases of avine mimicry have been recorded by Wallace,[1] who writes as follows: "More perfect cases of mimicry occur between some of the dull-coloured Orioles in the Malay Archipelago and a genus of large Honey-suckers — the Tropidorhynchi or 'Friar Birds.' These latter are powerful and noisy birds, which go in small flocks. They have long, curved, and sharp beaks, and powerful grasping claws; and they are quite able to defend themselves, often driving away Crows and Hawks which venture to approach them too nearly. The Orioles, on the other hand, are weak and timid birds, and trust chiefly to concealment and to their retiring habits to escape persecution. In each of the great islands of the Austro-Malayan region there is a distinct species of Tropidorhynchus, and there is always along with it an Oriole that exactly mimics it. All the Tropidorhynchi have a patch of bare black skin round the eyes and a ruff of curious pale recurved feathers on the nape, whence their name of Friar Birds, the ruff being supposed to resemble the cowl of a friar. These peculiarities are imitated in the Orioles by patches of feathers of corresponding

[1] *Darwinism*, pp. 263, 264.

colours; while the different tints of the two species in each island are exactly the same. Thus in Bouru both are earthy brown; in Ceram they are both washed with yellow ochre; in Timor the under surface is pale and the throat nearly white." Very remarkable is the fact that even a protuberance on the bill of the Honey-sucker is imitated by a similar peculiarity on that of the Oriole. Incidentally we may remark that Dr. Wallace, finding a peculiar form of Oriole on the island of Gilolo, was able to predict that a Friar Bird similar in appearance would some day be found there; and this it actually was! In Brazil we have a case of a fierce bird-eating Hawk imitating another Hawk perfectly harmless and feeding upon insects. But the most marvellous part about this is that in localities where the harmless bird is absent the rapacious species never adopts the disguise. Another interesting instance is furnished by a Bulbul of Madagascar imitating a Shrike found in the same country. Although the latter bird is dimorphic the Bulbul closely resembles or mimics feather for feather the two types of colouration.

The various Protective Colours and Resemblances of birds are little less wonderful. No

one can make a very exhaustive study of Birds without soon coming to the conclusion that colour plays a very important part, nay, many parts, in their economy. No matter what description of haunt we select, we are pretty sure to find within it birds of some kind presenting in various ways protective modifications of colour, not only for purposes of concealment from enemies, but in some cases to enable them better to steal upon their own prey. This protective colouration often runs almost universally through entire groups of birds. In the tropics, for instance, we have birds with the prevailing tints of their plumage yellow or green in many different families; and we can well understand of what vast service such hues are amongst the evergreen foliage. In more northern latitudes many of these gaudy-coloured birds would be conspicuous enough, but here in the virgin forests of the Equator their brilliant hues and violently contrasted tints harmonise completely with the vegetation.

But the protective colours of forest birds do not appeal so forcibly to the casual observer as some of the hues that deck species living in more open situations. Take desert birds, for example. These birds are almost invariably

clothed in plumage so exactly resembling in tint the ground upon which they live, that their discovery is next to impossible. We may literally walk up to these birds crouching upon the bare ground, and not one shall we see until it rises absolutely from under our feet. The Larks, the Buntings, the Finches, the Chats, the Bustards, the Coursers, and the Sand-Grouse are all clad in khaki hues. Our soldiers have but followed the birds in rendering themselves inconspicuous on the open veldt or the stony hillsides; and one would have thought that they had profited earlier by the example set them by dame Nature. We find the same great law prevailing upon the sandy coasts and mud flats where Plover and Sandpiper are decked in tints that harmonise closely with the colours around them. These protective hues of course are chiefly confined to the upper parts of the body. Nearly all these latter birds are white below—the most conspicuous hue in nature—and we also find that many desert species carry all their showy colours on the under surface of the body. These protective colours are the common heritage of all species dwelling in such regions, peculiar to no special group, although it is a significant fact that in

certain families where some of the species dwell in more wooded districts and others in deserts, it is only the latter that are modified in this special way. We can better illustrate our meaning by giving an instance. The Buntings, as a group, are bright-coloured birds, yet the Common Bunting is soberly arrayed in brown, which harmonises closely with the brown earth and the grey fallows upon which it loves to rest; whilst more significant still, we have the sand-coloured Saharan Bunting, which lives upon the North African deserts. Or yet again, the Sparrows are a bright-coloured conspicuous group, but when we reach the Sahara we meet with a beautiful cream-coloured species — the Passer simplex of ornithologists—which has discarded the typical Sparrow garb and clothed itself in the universal khaki instead.

Leaving the coasts and the deserts behind us and entering the marshes and swamps, we find other types of protective colouration. Here we have such birds as Snipes with their peculiar striated or lined colours blending beautifully with the ribbon-like leaves of grass or sedge ; or yet again, the Bitterns, in their garb of brown and yellow absolutely losing their identity amongst the tall brown stems and yellow leaves of the

marsh vegetation. In the latter case the Bitterns are aberrant in their general colouration, for the Herons as a group are showy and conspicuous birds—a deviation from the general prevailing colour of the family in obedience to that law of colour which insists upon harmony between bird and haunt. Out on the open moors and heaths a different kind of protective colouration again confronts us in the marvellous tints of the Red Grouse; whilst higher up the mountain sides the Ptarmigan in its pencilled dress assimilates most closely with the stones and lichens, and in winter (when its plumage is white) with the all-pervading snows. This latter modification, seasonal with the Ptarmigan, becomes constant in such birds as the Snowy Owl, the large Arctic Falcons, the Ivory Gull, and the Snowy Petrel, which all live permanently within the regions of almost perpetual snow. We must also call attention to the fact that all these birds which are protectively arrayed are endowed with the faculty of rendering their concealment as effective as possible, either by always alighting on spots where their tints harmonise the best with surrounding objects, or by crouching low to the ground, the tree trunk, the sand, and so forth, and there remaining absolutely

motionless until the threatened danger has passed. In these situations they often so closely resemble a stone, a clod of earth, an excrescence on the bark, a heap of leaves, or the stalk and leaves of surrounding plants, that discovery is next to impossible.

We will bring the present chapter to a close with a few remarks on the somewhat complicated and at present but little understood subjects of Variation and Dimorphism. Possibly few readers even remotely suspect to what an extent variation occurs among birds. The fact can only be realised by the actual examination of large series of individuals of the same species. Variation, as most persons know, is a very common phenomenon amongst domesticated birds and animals; it may never be so pronounced in wild birds, because of the strong tendency of natural selection to prevent it, but it is present in all to a degree that is not positively harmful to the species. When, however, it may reach an exceptionally pronounced type, such as in the case of an albino bird, it is invariably stamped out owing to its want of harmony with its environment. It is therefore no exaggeration to say that no two birds are exactly alike; the more minute the examination, the greater

the amount of variation becomes apparent. The larger the number of individuals we examine, the more shall we be impressed with the differences they present. Confining ourselves to external structure we shall find that the bill, the legs and feet, the wings and the tail, are all subject to individual variation, amounting in the two extremes to an astonishing degree of divergence. Colour is no less variable than structure. As we may view each individual of a large series of birds little or no difference in tint might be detected, but by placing the series—say of fifty or a hundred skins—side by side the important variation in tint at once becomes apparent. To a very considerable extent colour variation is correlated with geographical distribution, which in many cases means that differences of tint are due to climatic influences, as we have already seen. Then again, structural variation is often correlated with insulation, and often induced by it; for we often find the island representatives of a sedentary widely ranging continental species perceptibly larger or smaller than the others. It may also be due to geographical distribution, as in the case of the Crossbill, for instance. The difference in the size of the bill of the Common

Crossbill (Loxia curvirostra) and the Parrot Crossbill (Loxia pityopsittacus) is believed to be entirely due to the latter bird feeding on much harder food in the Scandinavian fir forests, whilst the former attacks smaller seeds and fruits. The researches of Messrs. Allen and Wallace have very clearly proved that the amount of variation usually reaches ten or twenty, or even twenty-five per cent. of the average size of the varying part, whilst from five to ten per cent. of the specimens examined present nearly as large an amount of variation. It is by means of this ever-present variation in every part of a bird (internal as well as external) that natural selection is able to work, and thus to harmonise it with its constantly changing conditions of existence in the struggle for life.

Among birds there are two very distinct kinds of Dimorphism. By this latter term is meant that in certain species constant and well-defined differences, either in form or colour, are found between individuals of the same species. First, then, we have that dimorphism which is entirely dependent upon secondary sexual characters; and, second, the dimorphism which may occur in either sex without any distinction. Cases of sexual dimorphism are so frequent amongst

birds that we might almost describe them as of universal prevalence. It may be seen in many different forms, but its most frequent type is that of general colouration. Innumerable instances may be called to mind by every reader at all familiar with birds in which the male is more showily dressed than the female, as, for example, in the Blackbird. More striking instances are furnished by species in which the male bird is adorned with crests or plumes, or other nuptial ornaments, or is armed with spurs, or decorated with tubercles, wattles, combs, and so forth. Sexual dimorphism also extends to the organs of voice, and such peculiarities as pouches and sacs. We have already noticed sexual dimorphism in the bill of the New Zealand Huia (*conf.* p. 194). In not a few cases it is manifest in size. In great numbers of birds the female is considerably bigger than the male, especially in the Birds of Prey; in other cases she is smaller, notably among the Galliformes and Ratitæ Birds.

Of dimorphism independent of sex the instances are much rarer; indeed, but few cases are known among birds. One of the most remarkable of these is furnished by several species of Skuas, which have two very distinct

phases of plumage, broadly described as a light one and a dark one. This peculiarity is not in any way a sexual one, and very often a male and female of each type of plumage may be noticed paired. Whether the Hooded Crow and the Carrion Crow are two types of a single dimorphic species seems not to be quite so well determined, ornithologists differing in opinion, some asserting that the birds are specifically distinct, although interbreeding. The peculiar variety of the Ringed or Bridled Guillemot may also be another instance of colour dimorphism. Of structural dimorphism independent of sex we may mention the large and small billed form of the Dunlin, and lastly the large and small race of the Wheatear.

CHAPTER VI

THE LOVE DISPLAYS OF BIRDS

Bird music—Vocal music of birds—Variety in song—Capriciousness of song—The origin and purpose of avine song—Individual variation in the song of birds—Imitation—Do birds sing by instinct or imitation?—Vocal sounds of birds—The instrumental music of birds—Made by ordinary appliances—Made by special modifications of the plumage—The drumming of the Snipe—Modifications in the wings of the Humming-Birds—In other species—Wing modification in the Manakins—Sounds made by air sacs or pouches—The love displays of birds—Aerial displays of Humming-Birds—Of Tyrant Birds—Love displays of the Birds of Paradise—Of Bustards—The love-posturing of the Argus Pheasant—The Bower Birds — Their curious "bowers" — The dances of certain Rails—Of the South American Jacana—Of the Spur-winged Plover—Of certain Ducks—Parades of plumage—The meaning and purpose of this display—Sexual selection—The vitality, excitability, and pugnacity of birds.

We will now proceed to the consideration of another class of phenomena peculiar to birds, and absolutely unique so far as all the rest of the animal kingdom is concerned. This more especially relates to the music or song of birds,

as well as their various love cries and sounds, together with those wonderful displays which are intimately connected with their courtship and their love. Bird music very naturally divides itself into two distinct classes; that is, it may either be vocal music, produced by the organs of voice, or it may be instrumental music, produced by certain purely mechanical means. The vocal music of birds is unquestionably the sweetest of all natural sounds, and one which, no matter how great the variety in which we may hear it, or how widely contrasted each song may be within the most limited area, is never out of harmony. Who ever heard a trace of discord in the avine chorus of the woods and fields? Now, this is a consummation to which even the human voice, and human music too, can make no pretension, with the possible exception, shall we say, of such gifted ears for melody as that famous Highland piper who, during the narration of his fighting and piping experiences to a few boon companions, is reported to have said: "It was ae grand nicht in Mrs. Glasse's wee back parlour in the Coogate—nineteen pipers besides her nain sel, a' playin' at the same time, an' a' playin' deeferent maisik, when I jist thocht I was floatin' tae

heeven on the hairmony"! From a popular point of view, song is very loosely associated with birds in general. All the smaller birds are very generally believed to sing in some way. The capacity for song, however, is comparatively a local one, practically confined to the Passeriformes, which, as we have already seen, are provided with a special apparatus for producing it (*conf.* p. 49). But even amongst the Passeres song is by no means a general accomplishment, and is practically confined not only to the smaller species of the group, but most developed in the duller-plumaged species. The music of birds, there can be little doubt, is one of the many forms in which natural beauty is expressed. But Nature is by no means lavish of her gifts, for few birds combine any marked vocal powers with brilliancy of plumage. These birds display their beauty in another way, by exhibiting it upon their painted wings, or plumes, or crests, and so forth. Another striking feature of bird music is its almost endless variety. If, however, we class music as a secondary sexual character, we need not feel surprised at its diversity, for of all characters, secondary sexual characters are the most variable, and modified in almost

endless ways. Another almost equally remarkable feature about avine song is what we may term the capriciousness of its possession. Few species form their songs out of the same combination of notes, and in many instances very closely allied birds differ remarkably in the quality of their voice. As a familiar instance we have the Willow Wren and the Chiffchaff, both very common little spring visitors to England, and so much alike that it requires some considerable knowledge of birds to distinguish them. But the Willow Wren possesses a charming and plaintive song, a little run of beautiful notes that form one of the sweetest bird-sounds in spring, whilst the Chiffchaff's attempt at music only amounts to a monotonous double note, not easily mistaken for that of any other British species. The high degree of organisation of the Passeriformes, and the fact that the special vocal organs for producing true song are peculiar to them, seem to indicate that the group is comparatively a recent one. The logical inference from this is that Song is but a recent acquirement among birds, and that the earth during the earlier eras of avine evolution was absolutely wanting in avine melody.

Much diversity of opinion prevails concerning

the origin and purpose of avine song. A very popular idea is that song, or the instinct of song, is but the outward expression of exuberant internal joy. The evidence, however, appears to be overwhelming that song originated in sexual rivalry, and has been developed and perfected, fostered and increased, by that stronger and more assertive vitality which is, without exception, so characteristic of birds with any pretensions to musical skill. Singing birds appeal to the female through their sweet and joyful cries; they sing their best and loudest, and warble one against the other in the heat of their passion, striving their hardest to outsing all rivals within hearing. Song also seems to be the agent of joy expression, and may also be indulged in as a pastime or diversion, many species singing more or less constantly throughout the year, and even when sexual rivalry is dormant. But it is a rule, without any exception whatever, that all song-birds sing their best when inspired by love, and that in no case does this music show the faintest decline in power at a season when pairing instincts are predominant. Song and sexual rivalry are resumed together each season, and the music dies away with the decline of that sexual stimulus. Song, we may remark, declines

perceptibly in brilliancy and persistency after the laying period is over, and the more acute stages of sexual strife are passed. That wondrous, if soberly arrayed, songster the Nightingale loses his sweet music as the young are hatched, and his entrancing voice becomes a disagreeable croak until passion inspires it anew the following season. The singing period of all song-birds is a season of irritation and war. Rival males sing at each other, chase each other from tree to tree, fight fiercely, and sometimes seem so lost in their ecstatic rage as to become oblivious to their own personal safety. Birds have been known actually to die under the violent exertions of song that a rival has inspired.

The very perceptible amount of individual variation in the song of birds must be mentioned. This is a very difficult study, for it requires a sensitive musical ear and some training to pursue it; and yet it forms a most promising and pleasing field of inquiry. Another puzzling question relating to song is the imitation of other birds' notes practised by various species. The standard of perfection in song is also by no means a constant or uniform one. We find a considerable range of variation in this as in all other things. This is especially

remarkable at the period when a species resumes its voice after months of silence, and in the maiden efforts of young individuals. All young birds are generally indifferent songsters, the art having to be learnt with considerable effort or practice; whilst some fully adult individuals, of probably every singing species, are much finer musicians than others, the song evidently improving with the age of the bird up to a certain period. Song, we should say, is almost entirely confined to the male sex; in some cases female birds have been known to sing, but their performance is generally confined to the utterance of a few twittering notes, and which probably represent what was once the best performance of the male at an earlier period in the history of the species—the crude beginning of a song which he has eventually developed into music of entrancing sweetness.

Now comes the question, whether birds sing by Instinct or by Imitation? The belief is a wide one, that young song-birds are hatched with an inherited ability to sing like their parents; able without tuition or experience to warble off the song characteristic of their species when the proper season arrives. This is an utterly erroneous assumption, with not a single scrap

of direct evidence to support it. Every bird-fancier knows full well how readily young birds acquire a song totally unlike that of their species. Many facts might be brought forward to prove that the songs of birds are acquired by Imitation, and that if young birds never have an opportunity of hearing the song peculiar to their species they are totally unable to produce it. A bird's song, then, is just as much an acquired faculty as the acquisition of a language by a child.

As we previously remarked, one of the most noteworthy characteristics of avine song is its extraordinary variability, not as applicable to the music itself (although the songs of some birds are infinitely varied), but with regard to the extent or degree of perfection which it has reached in the various species. We find every gradation of song, from the few harsh grating notes of some of the Buntings, or the simple trills of various Tits, for instance, to the finished and gloriously beautiful performances of certain of the Thrushes and Warblers. Amongst these singing Passeres then there are birds of which their vocal utterances are of the highest order—producers of that wonderful melody of voice that appeals with equal force and favour, if only coincidentally, to the most cultivated and

æsthetic human tastes as well as to their own pleasurable or passionate gratification. It is not within the scope of the present volume to describe in detail the songs of the various species, but before leaving the subject we ought perhaps to call attention to the fact that the action of birds during the utterance of their music varies considerably. Some species invariably sing whilst standing at rest, others when skipping to and fro in frantic joy, others when soaring or flying, others yet again accompanying their melody by a more or less display of plumage, or muscular action of the wings and tail.

We now pass to a consideration of certain vocal sounds, none of which reach the human standard of a song, appealing to no human taste as the exquisite melody of song universally does; many of them to our ears being most discordant, impressive, curious, or startling, though possibly appreciated by the sex to which in a great many cases they seem specially to be addressed. Sometimes they sound the signal of defiance, or the invitation to the fray. In a scientific sense these strange sounds, when uttered under the influence of love or passion, must all be classed as music or song. The familiar note of the Cuckoo, for instance, is confined to the

male, and uttered during the season of courtship and love only. Many of these strange sounds are an accompaniment to the various dances, displays, marches, evolutions, and antics that we shall shortly describe. Others, of course, are in no way connected with love or war, but serve as alarm notes, or to indicate the whereabouts of companions. In certain species the vocal organs differ very considerably in the two sexes, being then instances of audible sexual dimorphism. The boom of the Bittern, for instance, is one of the most extraordinary sounds in nature, and seems to be entirely a sexual production. Such a wild unearthly night-cry has very naturally become surrounded by superstition; the bird was thought to produce it by inserting its bill into a reed, or burying it deep in the mud. This boom consists of two perfectly distinct sounds, and is said to be produced as the bird inhales and exhales its breath. Then we have the piercing cries emitted by the Divers, well likened to the screams of tortured children; or the awe-inspiring notes of the Owls—all love cries, and claiming to be classed as avine music. Then the notes of the Goatsuckers are equally curious, and have in many cases been syllabled into such phrases as "Willy-come-go,"

"Whip-poor-Will," "Who-are-you?" and so forth. Again, some of the American Wood Hewers (Dendrocolaptidæ) assemble and indulge in a chorus of piercing cries, sounding like shrieks of insane laughter. Another extraordinary cry is that of the Bell-Bird of South America, the solemn tolling note of which, uttered at measured intervals, may be heard at a distance of several miles through the forests. During this performance the bird erects the peculiar appendage on the forehead. This consists of a spiral tube, nearly three inches long, jet black in colour, dotted with minute white feathers, and which by communication with the palate can be inflated with air and raised, but when empty it becomes pendulous. Another species, the Friar Bird of Australia, utters a cry which the colonists render as "More pork," or "Four o'clock." The Bustards, too, emit some strange vocal sounds during courtship; whilst the love notes of certain Grouse are curious, if not actually impressive. Then we have the call of another Australian species so like the cracking of a whip, that the producer of it has been named the "Coach-whip bird." Lastly, we may mention the musical trills — usually modulations of the call-note— peculiar to certain Sandpipers and Plovers,

heard only during the season of courtship and love.

We have now to deal with that varied assortment of sounds produced by mechanical means, and forming the second of the two classes into which we have divided avine music. This we have termed Instrumental Music, because the organs of voice take no part in its production. These sounds are produced in a variety of ways; not only by the bill, but by certain modifications of the feathers; whilst in some cases the ordinary plumage is so manipulated as to obtain the required effect. We may first draw attention to a few instances in which these sounds are produced by ordinary appliances. Many species of Woodpeckers have a habit of tapping with the bill the trunks or branches of trees; and if these chance to be hollow a noise is produced which can be heard for a considerable distance; whilst the bird's head is moved so rapidly that our eye can scarcely follow it. So loud is this noise, under certain favourable circumstances, that it seems as though the trees were actually being split asunder. These noises are for the most part peculiar to the nesting season, and most naturalists are agreed that they are signals between the sexes. Some birds are

vocally mute, as we have already seen, the organs of voice being absent or in a rudimentary condition only. These species succeed in making much sound by smartly snapping the two mandibles together. The Storks furnish us with a capital example of these bird mutes. What is technically known as the "klappering" of the Storks is a very remarkable performance, gone through not only as the birds stand upon the ground, but as they fly, often at vast heights. In producing this singular sound the bill is laid against the stomach or the back, and then the two mandibles are struck together so rapidly as to form a kind of trill, curiously modulated both in speed and tone. During the love season certain Game Birds produce various humming or rattling sounds with their wings at the time of courtship ; whilst some of the Nightjars make a booming noise with their wings. The common Nightjar of our English woodlands produces what is apparently a wing sound, as male and female chase each other in the evening gloom.

We will now proceed to glance at a few of the most curious and characteristic modifications of plumage which are utilised in the production of various sounds. Many of these special modifications are dimorphic and peculiar to the male

birds alone; in other species they are common to both sexes, but in these cases the males are generally the most specialised. As one of the most familiar instances of feather modification for the purpose of producing sound, we may mention the tail of the Common Snipe. In this species the outermost rectrices have a stiff sabre-shaped shaft; but it seems extremely doubtful whether the drumming sound that this Snipe makes in spring is produced entirely by this modification. It appears to be caused by the combined action of the wings and tail. During the love season the male Snipe, as if to parade his inordinate vanity, soars far up into the air, then suddenly descends on vibrating wings and outspread tail, making the peculiar bleating noise which seems to be produced by the air waves being driven by the powerful wing-beats through the expanded and rigid tail feathers. There are other species of Snipe in which the tail feathers are modified in a much more remarkable manner, as, for instance, in the Pin-tail Snipe (Scolopax stenura) of East Asia. This bird has no fewer than twenty-six rectrices, the outermost being little more than threads. The sound produced by this modification appears not to have been described by

naturalists, but it is doubtless a very extraordinary one.

Although we find a considerable amount of modification in the tails of birds, and especially in the Humming-Bird group, there can be little doubt that they are more for decorative purposes than for musical ones. Amongst the Humming-Birds the rectrices vary considerably in shape; but the modification of the wing is more important from a musical point of view. These feathers are moved rapidly, and can be manipulated better than the tail for the production of special sounds. We ought also to state that the wings of Humming-Birds are remarkably free from decorative colours, but on the other hand the tail is famous for the many glorious tints it displays, rivalling the rainbow in splendour. In this group the remiges are modified to an astonishing degree. In the genus Selasphorus the first primary is sharply pointed or abruptly excised at the tip; in Lafresnaya and Aglæactis it is very narrow, and sometimes curved inwards, upwards, or outwards, whilst in other genera the quills or shafts of the primaries are exceptionally thick or abnormally swollen, as in Campylopterus and Sphenoproctus. Most of these modifications are

peculiar to the adult males; and in one species at least (Selasphorus) we know that the flight during the mating season is accompanied by a shrill screeching noise said to resemble the sound made by a wood splinter touching a circular saw in rapid motion; the bird rising to some height and then descending like a flash, making the singular sound which does duty for a love note or song. This attenuated first primary is found in various birds very remotely related. It occurs in the American Woodcock, in the South American Guans, the Indian Lesser Florican, and Pallas's Sand-Grouse. The male of one species of Guan (Penelope nigra) is known to make a crashing noise like that of a falling tree, as he flies downwards: the Florican produces a deep-toned humming sound. The various modifications of the secondary quills are no less remarkable. Perhaps the most curious instances are furnished by the Manakins. Many of these species have the shafts of the secondaries abnormally thickened and the webs of various shapes. Even the bones of the wing are exceptionally strong and thick. These modifications are also dimorphic, confined to the male, the corresponding feathers in the wing of the female being of the normal shape. Most

peculiar sounds are produced by the aid of these feathers, for the birds are otherwise songless, the vocal muscles being absent in this group. One species makes a sharp sound like the crack of a whip, followed by a rasping sound similar to the call of the Corn-crake; another succeeds in making a sharp and whirring sound like that made by a small wooden rattle, followed by several sharp snaps. We ought also to mention in connection with the present subject that the males of some other birds are provided with air sacs or pouches, which they inflate during the period of courtship, just like bagpipes, and by the aid of which various booming or drumming sounds are produced.

We have now to consider that portion of the subject which deals with Display rather than with vocal or other sound; with those curious flights, posturings, love antics, and dances which may justly rank as some of the most remarkable phenomena in nature. This special kind of display, broadly speaking, may be divided into two distinct types: that indulged in by aerial species, and that peculiar to terrestrial species. In studying the subject we shall find it impossible to draw any arbitrary line between the various aerial movements of certain species,

often accompanied by the display of some special ornate development, and the terrestrial movements of others, likewise attended with the parade of certain decorations. Of the aerial performances we may here select a couple from the Humming-Birds. Stolzmann tells us how he watched entranced the aerial ballet of that marvellous racket-tailed Humming-Bird, the Loddigesia mirabilis. It is one of the rarest species, and down to 1880 (when Stolzmann practically rediscovered it) but a single skin was known in any scientific collection. He found that these Humming-Birds were in the habit of assembling at certain spots on the bare plateau to indulge in aerial movements. Two birds would first of all hover in the air opposite to one another with their bodies in a vertical position, then with expanded tail they flew first to one side then the other uttering a clicking note. Sometimes several males took part in this performance. At other times one bird would hang below a slender branch as another bird went through the mazy dance, when suddenly the position of the two performers would be exactly reversed, one taking the position and performing the actions of the other. Meantime the wonderful racket-shaped tail is moved in a

variety of ways, the spatulate ends sometimes being bent forwards almost to the crown of the head. This Humming-Bird is not a very brightly coloured one, the tail being apparently the principal decoration, and therefore manipulated accordingly. Belt observed two males of another Humming-Bird, the Florisuga mellivora, displaying their charms in a sort of friendly rivalry before a single female of the same species. First one would dart upwards, suddenly expanding the snow-white tail, which, like an inverted parachute, covered more space than the rest of the bird, and then gradually descend, turning slowly round, displaying both back and front; then the other would soar as its companion came down, going through precisely the same actions. Some of the Tyrant Birds are also remarkable for aerial display. One of these, Cnipolegus hudsoni, is black with a white bar on the wings. It is in the habit of sitting on a dead twig at the top of a bush, at intervals leaving this perch and beginning literally to waltz round and round in the air so rapidly that the wings, looking like a mixture of black, white and grey mist, make a loud humming sound. Just as suddenly this wild fantastic dance ceases, and the bird resumes its perch to

sit quite still until the performance is repeated. Many other instances might have been given of these aerial ballets, but we will now visit the tree-tops for an example of a stately minuet, which is danced among them by some of those gorgeous creatures the Birds of Paradise. The males of the Great Bird of Paradise assume their full wedding plumage in May, and during that month companies of them assemble at certain spots each morning to go through a kind of dance and display. These dancing parties are held in the tree-tops, a tree being selected with an extensive head of spreading branches, clothed with large scattered leaves, in which there is plenty of room to move about. Here perhaps a score of these gorgeous birds collect, raise their wings, and elevate their exquisite plumes, which are kept continually vibrated. Between whiles the birds fly across from branch to branch in great excitement, so that, as Wallace aptly says, the whole tree is filled with waving plumes in every variety of attitude and motion. During this performance the long plumes completely overshadow the bird, which is hidden in the golden glory waving above. The various displays of other species of these birds are equally interesting.

In some cases these displays take the form of posturing and deliberate movement. One of the biggest of these performers is the Great Bustard. The male throws himself into indiscribably odd attitudes during the recurring periods of courtship. Another Bustard, an Indian species (Otis bengalensis), puffs out his plumage in a very similar way, turning his tail right over his back, until he seems to be nothing but a shapeless mass of feathers, when he begins to strut about, bursting with pride, and as if entreating the female birds to come and admire his vain display. A still more remarkable instance of posturing is furnished by that very beautiful bird, the male Argus Pheasant. In this species the secondary quills are enormously developed, and each of them is ornamented with a row of circular spots on the outer web, besides being elegantly striped and marked with rows of smaller spots. These large spots are wonderfully shaded, and stand out like balls, resting loosely within cups or sockets. When about to display, he elevates his curiously elongated tail feathers, and throws out his bespangled wings into an almost circular shield, behind which the body is almost entirely hidden, the neck and head being held on one side, and he sometimes

peeps between two of the feathers. These males are not apparently very pugnacious, neither do they live in close companionship with the hens, but clear an open space in the forest which they keep very clean and tidy, removing all dead leaves and twigs for a space about eight yards square. Here, in this sort of drawing-room, they spend much of their time in solitary state, uttering notes of invitation to, and awaiting visits from, the hens, when they perform a dance, and give a display of their charms for the benefit of the latter. Very curious dances or displays are indulged in by the Cock of the Rock and the Ruff. Again, many of the Game Birds are notorious for their gatherings during the love season for a similar purpose. These displays often terminate in combats between rival males.

In many cases these dances and displays take place in certain recognised meeting-places, the birds of both sexes resorting to a common rendezvous. But even more extraordinary are those birds that actually build an elaborate and often highly decorated structure in which to conduct the antics or posturings incidental to their courtship. These are the famous Bower Birds. Incredible as the fact may be, it really

seems as though these gifted, if plain-looking birds sought by absolutely artificial means to add to their attractiveness. Certainly they exhibit an æsthetic taste for the beautiful immeasurably greater and more refined than that of the Australian aborigines themselves, and an appreciation of beauty for its own sake which can only find its parallel amongst the most highly civilised races of mankind. These bowers, avenues, or runs vary a good deal in shape and material amongst the several species, but they are all constructed for a similar purpose, and have nothing whatever to do with the nest. Some of these bowers are made of twigs, and are decorated with feathers, shells, bones, and leaves; and in the collection of these materials the birds must expend a very great amount of labour. In the bower of the Spotted Bower Bird the decorations are very profuse, and little paths strewn with stones diverge from the mouth of the bower. The most wonderful bower of all is that made by the Gardener Bower Bird. This species builds an elaborate circular hut-like structure at the foot of some large tree, and about two feet high and three feet in diameter. It is formed of the stems of orchids, which radiate and slope to the ground from a

central support, crowned with a mass of moss, and sheltering a gallery round it. One side of this hut is left open, and in front of it is what has been aptly termed "the garden." It consists of a bed of green moss, decorated and bedecked with the most brilliantly-coloured berries and flowers, and is some six or eight feet in expanse. Marvellous as it may seem, the bird removes the garden ornaments as they wither, and casts them into a heap at the back of the premises, gathering a fresh supply! Through and about these bowers the male birds strut and pace and race after the hens that resort to them, becoming excited almost to frenzy in the mad strange dance and curious antic.

It would seem that the displays of some birds, like the songs of others, are indulged in for the sole sake of pleasurable excitement. Science is indebted to Mr. Hudson for a record of some of these curious performances, of which he was actually an eye-witness. Some of the Rails join in these festive dances, which we can only liken to balls. In South America there is a species known as the Ypecaha Rail, which is in the habit of assembling at some chosen spot, usually a small patch of smooth level ground close to the water, and surrounded by tall dense reeds. First one of

the birds utters a thrice-repeated cry, apparently a note of invitation, responded to by birds on all sides, which hurriedly repair to the recognised trysting-place. Perhaps a score birds so congregate, bursting through the reeds and running on to the open space, when the singular performance commences. Mr. Hudson describes this as a "tremendous screaming concert," screams, shrieks, and moans being uttered in quick succession, and all the time the birds rush from side to side as if gone mad, the wings extended and vibrating, and the long beak opened wide and raised vertically. The whole performance lasts but a few minutes, after which the birds disperse to their own particular haunts.

Still more curious is the festive dance of a species of South American Jacana, a performance which Mr. Hudson tells us seems specially designed to bring out the concealed beauty of the silky greenish-golden wing feathers. These birds live in pairs, and sometimes a dozen may be seen feeding on marshy ground within sight of each other. In response to a note of invitation from one of the birds, the others cease feeding, and fly to a certain spot, where, forming a close cluster and uttering excited notes, they display their wings like flags grouped closely

together, or wave them up and down with slow, measured beats. In both these displays males as well as females appear to take part.

But even yet more curious than all is said to be the dance of the Spur-winged Plover of the same region. This unique display is called by the natives its dance, or square dance, and three birds are required for its due performance; and it is said that the birds are so fond of it that they indulge in it all the year round, not only during the day but on moonlight nights as well. These Lapwings live in pairs, and suddenly the male of a neighbouring pair will leave his mate and fly up to this pair, by whom he is received with notes of apparent pleasure. Then the three form a procession, the visitor walking in front and followed by his hosts, all keeping step and marching rapidly to the utterance of a resonant drumming note to which they keep time with their movements. The notes of the pair behind are uttered like a drum-roll, but the leader gives forth loud single notes at intervals. Presently the march stops, the visitor elevates his wings and stands motionless, whilst the other two, exactly abreast, sink their voice to a murmur, and stoop forward and downward as though making their bow, and in this attitude remain

for some time. This concludes the performance, when the visitor returns to his own quarters and to his mate, to receive in turn a single visitor themselves later on.

Something very similar to the strange antics recorded above may be noticed amongst the various species of Ducks during the nuptial period. These birds may not unfrequently be watched quietly swimming, when suddenly, and for no apparent cause, the male and female will commence a sort of aquatic hide-and-seek, accompanied by no small amount of uproar. Just as suddenly will this strange frolic cease, and the birds, facing each other, will exchange bows with great regularity, either together or precisely in turn.

Incidentally we may mention that occasionally birds that usually display by vocal effort resort to a parade of plumage. The Robin is an example of this. On the evening of the 24th February of the present year, we witnessed on our lawn a most interesting display by three male Robins. Each bird in turn raised its head until the bill pointed nearly perpendicularly to the sky, and slowly swayed the orange breast from side to side as if in defiance; the other birds, evidently greatly excited by the exhibition

(which to us seemed to be a kind of challenge), eventually hopping up and buffeting the one thus showing off. There could be no possible doubt that these male Robins were seeking to display the colour of their breasts to best advantage. No females were in sight, and each bird all the time kept its tail elevated almost over its back, and was evidently full of excitement. No song accompanied this display, which is all the more remarkable, because the Robin is one of the most pugnacious and pertinacious singers in the entire order. The vernal soaring flights of the Chaffinch are also very beautiful. These take place when two rival males meet, and are never, so far as we can determine, accompanied by song or note of any kind. The two birds rise perpendicularly in the air, sometimes for thirty feet or more, buffeting each other all the time, then coming down in much the same way. Time after time will these quarrelsome flights take place, the effect of the particoloured wings being extremely pretty.

In concluding this brief survey of avine song and display, a few words seem necessary concerning their meaning and purpose. Darwin sought to weave all this display of song and dance and antic into his masterly conception

of Sexual Selection, and from a cursory review of the facts this seems to be a very plausible and possible explanation of the phenomenon. The subject, however, has been much more minutely investigated since Darwin worked and wrote, and a vast array of facts has been collected which not only tend to weaken his brilliant hypothesis, but alsolutely to refute it. The keystone of Darwin's arch was the taste or choice of the female bird for certain characteristics either ornate, musical, or terpsichorean, in the male. But Taste or Choice is one of the least constant things in this world. Darwin's theory demands the practically impossible coincidence of choice throughout entire species and groups of species, which, we venture to assert, is demanding far too much from the female members of them. All the evidence tends to show that this song and display are prompted by impulses of pleasure or rage, and that spontaneous vitality which is invariably attendant upon robust health. The impulse to pair becomes strongest when life is in the full tide of its vigour, seasonably after maturity; and these are the periods when ornaments are brightest, when songs are gladdest, and when display of all kinds is most vigorous. Male

birds find an outlet for their excessive vitality and superabundant energy in the development of showy plume, sweet song, and wild display. Another fact about much of this song and display, which seems absolutely fatal to any hypothesis of sexual selection, is that in innumerable instances the male birds indulge in them at times when it is perfectly obvious no female choice could be exerted. We may repeat here what we have already expressed in a former volume as our deliberate opinion upon this question. The various species that are exceptionally adorned are also remarkable for the extraordinary vitality, excitability, and pugnacity of the males; and these qualities are more or less frequently being invoked for the display of such ornament, or in combat with rivals or intruders. The meeting of a rival, the sexual excitement provoked by the presence of the female, or even the intrusion of some stranger species into the sacred precincts of a favourite haunt, is almost invariably the signal for the erection of a crest or plume, the display of a spangled wing or tail, the inflation of a pouch or sac, or the assumption of an attitude in which the special decoration of the species is displayed to its utmost advantage, a declaration of defiance

or an outward manifestation of conjugal passion. There can be little doubt that the display of so much excessive or supplementary vitality, in the form of dimorphic secondary sexual characters, has an overpowering effect upon the female, quite irrespective of any conscious choice or selection on her part; and that, so overcome, she yields to the embrace of the strongest and most energetic male that, in spite of rival claims, can take and keep her.

CHAPTER VII

THEIR REPRODUCTION (NESTS)

The unique character of birds' nests—The architecture of Ratitæ Birds—The nests of the Kingfishers—The Hornbills—The Swifts—Edible nests—The nests of the Humming-Birds—Nests of the Passeriformes—Great variety in the nests of the Passeres—Variation of nest-type in the same species—Uniformity in the nests of species—The architecture of the Wrens—Of the Swallows—Of the Finches—Of the Starlings, Shrikes, Waxwings, Orioles, and Goldcrests—Nests of the Tropical Oscines—In the Timeliidæ—The Tailor Bird—Nests of the Bulbuls, Cuckoo Shrikes, Drongos, and Greenlets—Of the Birds of Paradise—Of the Sun-Birds—Of the Flower-peckers and Sugar Birds—Of the Wood Warblers and Tanagers—Of the Weaver Birds—Of the Ox Birds and Hang-nests—Of the Broadbills—Of the Pittas—Of the Tyrant Birds—Of the Cotingas and Plant-cutters—The nest of the Oven Birds—The architecture in the Wood Hewer family—Of the Ant Thrushes—Of the Lyre Birds—Nest of the Hammer-Head—Nests of the Mound Birds—Of the Brush Turkeys—Of certain Coursers—Of the Rails, Ducks, and Geese—Of the Flamingoes—The utility of nests—The nest in relation to the colour of the plumage—Instinct or imitation in nest-building.

THE beautiful songs, the curious cries and sounds, the varied posturings, antics, gestures, and aerial gambols of birds, described in the previous chapter,

are in most cases the preliminaries to the function of Reproduction—the prelude, as it were, to the making of Nests and the laying of Eggs. As in so many other ways, we find birds practically unique in the wonderful and elaborate preparation they make for the reproduction of their kind. Birds' nests are at once the most beautiful and the most curious cradles throughout the animal kingdom. Their production not only requires a great amount of skill, but reflects intelligence of no mean order. We shall find, however, that the nest-building capabilities of birds are subject to a very wide range of variation, and in not a few species are entirely absent. It is not all birds that make nests; and we find an almost perfect gradation from nestless species through the crudest provision becoming more and more elaborate, until we reach those wonderful structures that excite universal admiration. There are birds, for instance, such as the Guillemot, that lay their eggs on the bare rocks, or on the open ground, like the Goatsucker and the Lapwing; there are others, like the Ostrich, that make no nest, but bury their eggs in the sand; whilst many species that breed in holes deposit their eggs upon the powdered wood at the bottom, making no provision in the form of a bed. Then

we reach the crude ground-built nests of the Waders, and kindred forms—the simplest provision, consisting merely of a slight hollow with a few bents and grasses carelessly arranged therein. Reaching higher types of nests still, we have, for example, the crude heaps of vegetation formed by the Grebes and Rails, the slight structures made by the Pigeons, and so forth. Then there are other species that appear to require a nest, but object to make one for themselves, and so annex the deserted home of some other bird. Some species form a bed for the eggs out of the refuse of their food; others secrete a salivary fluid, which soon hardens when exposed to the air, and forms a nest layer by layer. It is amongst the Passeriformes that we find the most remarkable avine architects, presenting an almost bewildering variety in the form and structure of their nests. Of course it would be utterly impossible to compress into a single chapter sufficient material for a portly volume. All that we can do is briefly to glance at the most characteristic types and at a few of the more remarkable structures.

As might naturally be expected, we find a very low type of architecture, or even an entire absence of nest, amongst Ratitæ Birds. The Ostriches

and Rheas lay their eggs on the bare ground; the Cassowaries and Emus scrape out a small hollow, placing a few bits of grass or various plant-stems round the margin; whilst the Kiwis, more elaborate in their provision, excavate a short tunnel in a chamber, at the end of which they make a rude nest of dry fern fronds and other herbage. We have already briefly indicated the usual type of nest in each of the great avine groups, so that it will be unnecessary to repeat it here. To this, however, there were two exceptions, the orders being too heterogeneous to admit of any generalisation with regard to the nesting arrangements. These were the Coraciiformes and the Passeriformes; the former containing certain species remarkable for their mode of architecture, the latter a group in which nest-building may, generally speaking, be said to reach its highest degree of perfection. It is in these groups, therefore, that a more detailed account of the various types of nest seems to be most necessary. The Kingfishers, for instance, are very interesting in their method of nesting. Many of the species tunnel into banks of rivers and pools, forming a gallery several feet in length, the end of which is enlarged into a kind of chamber. Here a heap of fish-bones is

gradually accumulated (the birds frequenting the spot all the year round), the indigestible parts of the food that are cast, and upon this bed the eggs are deposited. The Hornbills are also remarkable for their very singular methods of nidification. They breed in holes in trees, a circumstance about which there is nothing very remarkable in the present order; but as soon as the eggs are laid, the female either builds herself in the hole, or the male does so for her, plastering up the entrance until but sufficient space is left for the cock bird to pass food to her. Here a voluntary prisoner she remains until her task is done, emerging emaciated and with worn and draggled plumage when the eggs are hatched. It is worthy of remark that in the Hoopoes the females evince a similar disinclination to leave the nest hole, the males feeding them during the whole period of incubation. Then in the nidification of the Swifts there is much of exceptional interest, for to this family belong the species which make the famous edible nests, so highly prized in the Far East as articles of food. These birds, belonging to the genus Collocalia, breed in caves. The best quality of these nests resembling isinglass, and formed from a gelatinous secretion from the salivary glands,

are worth their weight in silver, and are found in caves in limestone and volcanic rocks; those from caves in a sandstone formation being of inferior value. There are usually three crops of these nests gathered in a season, the second being the best. Their value depends upon their purity or freedom from foreign substances, such as dirt and feathers. The best quality nests are white, the second quality is yellow, whilst the third is discoloured and impure. The nests of some other of the Swifts are very interesting. A Guatemalan species is said to attach its tubular nest to a rock with saliva, the nest itself being made of seeds, each seed cemented together with a similar secretion.

The last family in this order famous for the nest-building capacities of its members is the Trochilidæ. It is somewhat remarkable that the Humming-Birds should not only excel as nest-builders, but should depart so widely from the general rule prevailing in the order as to make elaborate structures in the open. As we have already seen, the majority of the Coraciiforms breed in holes, and make but slight nests, or even dispense with nests altogether, laying their eggs upon the powdered wood only. Some of the most exquisite nests that are known are

made by the Humming-Birds—tiny structures not a few of them, little bigger than a good-sized thimble, yet perfectly finished and a model of neatness. All the species, so far as is known, build on one general model—an open cup-shaped structure—although the manner in which they are attached to the various objects that support them differs considerably. The materials are such that admit of easy and effectual felting together—lichens, vegetable downs, small feathers, wool, hair, moss, and spiders' webs. In most cases this nest is attached to the upper surface of a branch; in other cases the nest is horn-shaped, and fastened to the surface or point of some ribbon-like leaf, or placed in the centre of a bunch of leaves. More rarely the purse-shaped nest is attached to a cliff. Gould, who made this family an object of very careful study and published a magnificent monograph of the species, asserted that in some cases the pensile nests were weighted with a little stone or piece of earth should one side of the structure be heavier than the other, in order to ensure equilibrium. One very striking feature in Humming-Birds' nests is the manner in which they are made to assimilate with surrounding objects, by a garniture of lichens, spiders' webs, and so

forth, just as our own Long-tailed Tit and Chaffinch are in the habit of doing. The Humming-Birds seem very much attached to certain nesting-places, often returning to them each season, and they have been known to make a new nest on the remains of the old ones for several years in succession.

We now come to a consideration of the various types of nests peculiar to the Passeriformes. This order is divisible into a very large number of families, but the nests in each are by no means confined to certain types, and the variation in their structure is by no means correlated with affinity. Indeed, it is by no means unusual to find several very distinct types of nest in a single family or even in the same genus, whilst in other cases a certain type of nest will run through more or less distantly related groups. The variety in the nests of the Passeres can only be described as amazing, and must be taken as an indication of the high degree of specialisation to which the order has attained, of their wonderful intelligence and power of adapting themselves to a multitude of conditions and circumstances. We have many remarkable instances of this variation of nest-type even amongst familiar British species. Take the Corvidæ or Crows

as our first example. Even among the few British species we find a variety and an adaptability that is little less than astonishing. The Rook, the Jay, and the Crow make their large nests in trees; the Raven not only builds in trees but on cliffs, as also does the Hooded Crow; the Jackdaw and the Chough seek a hole in a tree, cliff, or building; whilst the Magpie adopts a style of architecture peculiar to itself, and makes a huge nest which is securely roofed in by an almost impenetrable mass of sticks. Then amongst the Titmice we have the cup-shaped structure of moss, wool, feathers, and the like, snugly hidden in a hole of a wall or a tree, and the beautiful globular home of the Long-tailed Tit (made of moss, wool, grass, hair, and feathers), garnished externally with lichens and spiders' webs, built in bushes and small trees. In this latter group we have an instance of a dual type of nest even in the same species; for the Great Titmouse when nesting in a hole of a tree makes a cup-shaped structure, and when doing so in the deserted home of a Crow or Magpie it constructs a perfectly globular nest of moss and feathers. Then in our two species of Flycatcher we find that the Spotted species makes a cup-shaped nest of grass, twigs, moss, wool, and

feathers, &c., which it places on a branch near the stem, or even on trellis-work or masonry, whilst the Pied species selects a hole in a tree in which to hide its nest, made of similar materials. Similar diversity of nest-building is presented by the Warblers, some of these birds making flimsy net-like nests of bents and hair, which are attached to twigs or reeds or concealed amongst vegetation, whilst others (as the Willow Wrens) make globular structures lined with feathers, which they place amongst the herbage. On the other hand the architecture of some species is remarkably uniform. The Dippers, for instance, occupying a vast geographical area, build but one type of nest, a domed structure of moss, grass and leaves. This uniformity may be due either to the great similarity of conditions of life to which all the members of the family are exposed, or to their somewhat ancient origin; for we generally find the least diversity of architecture in the older groups. In the Larks the type of nest—an open cup-shaped structure made of grass, bents, and dead leaves, lined with hair—is remarkably uniform, and generally made on the ground amongst herbage; but some of the species (Mirafra) build domed structures. The Wagtails

are another family of fairly uniform nest-building habits, usually placing their substantial cradles (made of dry grass, bents, roots, and moss, lined with wool, hair, and feathers) in well-sheltered spots—holes in walls or under stones and turfs ; the Pipits place their nests, not so elaborate as the Wagtails, amongst herbage in the open, although one or two species love to hide them under stones and rocks. In the Thrush family (Turdidæ) we again meet with considerable diversity of nest. All the Thrushes, of which our Song Thrush may be taken as typical, and all the Ouzels, of which the Blackbird is an excellent example, build open cup-shaped nests of grass, moss, leaves, and twigs, cemented with mud (and in some cases lined with decayed wood), and finally lined with dry grass ; placing them in bushes, trees, or on the ground in banks, amongst ivy, and so forth. The Rock Thrushes and Wheatears make nests of dry grass lined with hair and feathers in the latter group, and cunningly conceal them in holes of rocks, or under stones, and in burrows. The Redstarts use similar materials, hiding their nests in holes of trees and rocks and walls. The Stonechats and Whinchats make nests of dry grass, hair,

and feathers, placing them in open sites amongst herbage and at the foot of dense bushes.

Passing on to the Wrens (Troglodytidæ) we find a domed nest as the most typical, made of moss, dry fronds and leaves, bents, rootlets, and twigs, lined with hair and feathers, and placed in bushes, under banks, amongst trailing or creeping plants, in crevices of rocks, and so forth; but in some few genera the style of nest is open; and in another we have a purse-like structure entered by a long passage of woven materials. Then again the Swallows (Hirundinidæ) present us with an exceptional amount of diversity in the plan of their nests. We find species like the Sand Martin tunnelling into banks, and forming a rude nest of dry grass and feathers; others, like the Swallow, building a saucer-shaped home composed externally of mud and lined with straws, grass, and feathers, placed in outhouses, caves, &c.; others, like the House Martin, globular, with an entrance near the top, and cemented to rocks or masonry, or retort-shaped with a long tube for entrance at the side, in similar situations; whilst some species utilise the nests of other birds, and make their own abodes in that of their host. The Finches (Fringillidæ) are remarkably uniform in their type of nest. This

is generally an open cup-shaped structure of varying degrees of depth, containing abundance of material and warmly lined. The usual materials are twigs, straws, dry grass, moss, wool, vegetable down, hair, and feathers; whilst some species garnish their nests with lichens, cobwebs, bits of paper, and so forth. In some nests some of the above-mentioned materials predominate, and *vice versa*. Some of the Finches are rather untidy builders, others are marvellously neat. What, for instance, could be more slovenly than the nest of the House Sparrow, especially when made in a covered site; whilst what could possibly be neater than the lovely little nest of the Goldfinch or the Chaffinch? Incidentally we should mention that the House Sparrow builds a double type of nest, domed when in trees, more or less open when in holes. The situation of the nest varies considerably, some species building in bushes, trees, hedges, buildings, or even cliffs (as for instance the House Sparrow), others seeking sites on the ground or amongst tall plants or even in crevices of rocks, as in the Buntings. The shallowest types of nest are those made by the Hawfinches and Bullfinches; the deepest by such forms as Sparrows, Chaffinches, and Redpoles. The typical Finches are

the neatest builders; the Buntings the least so, their nests seldom being very elaborate and rarely lined with warm materials. In the Starlings (Sturnidæ) the more typical species build slovenly nests of straws, grass, wool, feathers, &c., in holes of trees, walls, or even under heaps of stones, and in burrows; but some of the more aberrant forms construct nests in the open, in trees or bushes, and in these cases a globular structure is made. The Shrikes always appear to make open cup-shaped nests, of twigs, dry grass, plant stems, moss, wool, hair, and feathers, placing them in trees and bushes. The Waxwings also build open nests, very similar in general form, and placed in trees. The nests of the Orioles (Oriolidæ) introduce us to another type of avine architecture, these being slung between forking branches, the rim of the nest being worked or woven over the supporting twigs; the materials are chiefly the leaves and stems of grasses, various fibres and bark strips, and occasionally bits of paper. The nests of the Goldcrests (Regulidæ) are made on a very similar plan, only suspended from the ends of fir branches, and made largely of moss, lichens, and spiders' webs, lined with feathers.

We now come to the more tropical ranging

members of the Passeriformes contained in the group Oscines (*conf.* p. 101). Here also we find a very similar diversity of structure in the nests, not only in the various families but in the different genera. In the Timeliidæ, for instance, there is almost every type of nest to be found, but domed or otherwise concealed nests are very prevalent. Warm linings, however, are not so general, grass, dead leaves, fibres, moss, and twigs being the usual materials. The Tailor Bird (Orthotomus longicauda) makes a wonderful nest; selecting a broad leaf, and drawing the edges together with fibres (which are actually knotted), lining the cone thus formed with fine grass and vegetable down. Some of the Australian forms (as in Pomatorhinus) fabricate huge domed nests of twigs lined with feathers, adding to them a spout-like entrance, and placing them at the extremities of branches. The Bulbuls (Pycnonotidæ) chiefly build somewhat flimsy open nests, placing them in trees and bushes, but in one genus (Iole) they are suspended like the Orioles. The Cuckoo Shrikes (Campephagidæ) and the Drongos (Dicruridæ) also make open cup-shaped nests, placing them in bushes and trees; so also do the Greenlets (Vireonidæ), in many cases, however, slinging them like that

of the Goldcrest between forking branches. The Birds of Paradise (Paradiseidæ), so far as is known, make open cup-shaped nests of sticks, twigs, dead leaves, moss, fibres, and grass, placing them in bushes and trees. The Honey-eaters (Meliphagidæ) and the White-eyes (Zosteropidæ) have a habit of slinging their cup-shaped nests between forks, weaving the rim round them, and are somewhat exceptional in providing a lining of vegetable down or feathers. The nests of the beautiful Sun-Birds (Nectariniidæ) are of a very interesting type, domed and pear-shaped in form, often with a porched entrance, and suspended from slender branches or the under surfaces of big leaves. They are very neatly made of grasses, moss, fibres, and roots, and lined with hair, feathers, and vegetable down, being partly attached to the supporting stem or leaf by spiders' webs. Lichens, cocoons, scraps of bark, or even bits of paper are often added by way of garniture and to render them in harmony with surrounding objects, the better to conceal them. Some of the Flower-peckers (Dicæidæ) make very similar structures. The Sugar Birds (Cœrebidæ) build domed nests of dry grass, roots, fibres, feathers, and the like, some of them also having a projecting porch.

The Wood Warblers (Mniotiltidæ) build cup-shaped open nests in trees and bushes, fabricating them of dry grass, leaves, moss, twigs, roots, and lichens, and lining them with hair and feathers. Those of the Tanagers (Tanagridæ) are very similar, but not so deep or so warmly lined. The Weaver Birds (Ploceidæ) are also wonderful little architects, their nests usually being retort-shaped or globular, with a long neck for entrance, which may either curve downwards or be almost horizontal. In the nests of some species there is little or no neck, and the purse-shaped structure is suspended from a branch with a cunningly-woven string. The materials are dry grasses, twigs, roots, and leaves externally, lined with feathers, vegetable down, or even wool. Many of these birds build in societies, each pair of birds contributing in making a huge umbrella-like structure in a tree, the under surface being nearly flat and full of holes, in which the eggs are deposited. Some of these extraordinary co-operative nests contain a cartload or more of grass, and at a distance look like native huts. They are used by the Weaver Birds year after year, and added to and repaired as may be required. The Ox Birds (Textor) form very similar structures. Across the entrance of some

of these pensile nests a guard is woven to prevent the contents from falling out during high winds. Sometimes great numbers may be seen hanging from a single tree; whilst in Burma there are few thatched houses without many of these hanging nests dangling from the eaves. The American Hang-nests (Icteridæ) build very similar pensile nests, varying in form from nearly globular to almost every variety of retort or bottle shape, some being as much as a yard or even more in length. In some species the nests are slung like hammocks, in others, especially in the South American Cassiques, they hang like long-necked flagons from the trees. These nests are made of various wiry grasses, fibres, moss, and hair. In some cases the outside of the nest is attached to some convenient twig, the better to steady it and prevent the contents from being spilled. It has probably occurred to the reader ere this that these penduline nests suspended from tapering branches and drooping leaves are a very frequent type in tropical countries, and are made by many remotely related species. They unquestionably serve the common purpose of protecting their contents from the attacks of snakes and monkeys and other predatory creatures, so that their singular beauty is purely a utilitarian one.

In the other groups of the Passeriformes we have the Broadbills (Eurylæmidæ), in which the nest is oval, the entrance being on the side near the top, sometimes protected with a sort of porch, or at other times prolonged into a tapering structure below. They are made of twigs, roots, grass, moss, and leaves, and lined with green foliage, which is frequently replenished when withered as is also the case, by the way, with some of the Birds of Prey (the Eagles and Buzzards, &c.), and placed suspended from drooping branches, often over water. The Pittas (Pittidæ) are mostly ground builders, and make globular nests, with a side entrance of twigs, roots, grass, moss, and fibres, in some cases cemented with mud. There are several types of nest amongst the Tyrant Birds (Tyrannida). These are made of twigs, grass, moss, wool, and hair (sometimes such abnormal materials as rags, paper), felted in some species with lichens and cobwebs, and are either cup-shaped and open or domed. They are usually placed in trees or bushes. There is nothing specially remarkable about the nests of the Manakins (Pipridæ), but in the Cotingas (Cotingidæ) there are several types of exceptional interest. The Cock of the Rock (Rupicola) makes a nest of mud and twigs, lined with moss,

and attaches it to the rocky sides of some dark cave. Some other species build hanging nests of leaves, stalks and wool, with a lateral entrance; others form cup-like structures of lichens and moss, placing them in forks of trees. The Plant-cutters (Phytotomidæ) have nothing uncommon in their methods of nest-building, but in the Wood Hewers (Dendrocolaptidæ) we are again introduced to a great variety of avine architecture. Perhaps in no other family of birds do we find so great a diversity in the nests. To this family belong the famous Oven Birds (Funarius). The Red Oven Bird is said by competent observers to begin nest-building in autumn, and to continue the task right through the ensuing winter. The wonderful structure is frequently placed in the most conspicuous positions, on the top of fences or boulders of rock, on some giant cactus, or amongst the trellis-work on houses, and sometimes several of these curious ovens are made close together. This oven is nearly globular in form, and is made of clay mixed with bits of straw, horse-hair, and fibres. In the front there is an upright opening, the wall on one side of this curving inwards, forming a partition nearly to the back (something like a univalve shell), and leaving there a narrow passage, which

leads into a second chamber, where the nest is completed with a bed of soft dry grass. The whole concern measures about a foot in diameter, and may weigh as much as ten pounds. As pointed out by Mr. Hudson, who has had exceptional facilities for studying many species of Wood Hewers, some other species excavate in the earth, making long cylindrical burrows four or five feet in length, terminating in a round nest chamber; others that are of arboreal habits nest in holes in wood. The marsh-frequenting species attach spherical or oval domed nests to the reeds, in some cases woven grass and clay being so cleverly combined that the structure is impervious to wet, practically indestructible, and light as a basket. Another type is a large structure made of sticks, placed in bushes and trees, to make and keep in repair which the owners work more or less constantly all the year round. These stick nests vary greatly in size and shape. Some have a spiral passage leading from the entrance to the cavity where the eggs are deposited, this being in many cases only just big enough to hold the owner. In another species, however (Homorus gutturalis), this nest cavity is so large that "if the upper half of the nest or dome were removed, a Condor could comfortably

hatch her eggs and rear her young in it." Another species in the same genus (H. lophotis) builds a similarly large nest, outwardly resembling a gigantic powder-flask, placed horizontally on the lower branches of a spreading tree. Another species (Pracellodomus sibilatrix), about the size of a House Sparrow, makes so huge a nest, at the extremity of a horizontal branch, ten or fifteen feet from the ground, that its weight when completed bends the branch down to within a few feet of the earth. Some of the species in the genus Synallaxis also make very curious homes. One of these (S. phryganophila) makes a stick nest about twelve inches deep, from the top to the bottom of which runs a tubular passage of finely interlaced twigs, "like a rain-pipe on the wall of a house," and then, passing outside, slopes upward, and finally terminates some two or three feet from the actual nest. Another species (the S. erythrothorax, of Yucatan) makes so large a nest of sticks, that the natives believe the builders are assisted by all the birds in the forest. In some parts of South America these nests are very abundant, upwards of two hundred of them having been counted, varying in size from a small pumpkin to a barrel, in thorn trees within an area of twenty rods, some of the

trees containing half-a-dozen. Another species weaves a small straight tube out of grass, open at both ends, and the aperture only large enough to admit the finger, the parent bird having to pass right through without turning round! Yet another species scoops out a round hollow in the ground, and builds over it a dome of finely-woven grass. As the nests of only some fifteen species are known, out of a total of sixty-five composing the entire family, we may reasonably conclude that the architectural variety of the Wood Hewers is by no means yet completely known.

There is nothing specially remarkable about the nidification of the so-called Ant Thrushes (Formicariidæ), these birds mostly building shallow open nests in trees or bushes of straws, grasses, fibres, moss, roots, wool, and hair. Neither do we find much worthy of special comment in the next family (Pteroptochidæ), although there are several apparent types of architecture, some species nesting in burrows, others making domed nests of grass, others open ones of sticks. Lastly, we may mention that the Lyre Birds (Menuridæ) build domed and oval nests, made of sticks, grass, fibres, leaves, fern fronds, moss, lined with roots and feathers.

We will conclude this necessarily brief survey of avine architecture by a detailed notice of a few somewhat aberrant forms of nidification. There is, for instance, the very curious nest of the Hammer Head (Scopus umbretta). This bird is about the size of a Raven, and yet it builds a huge nest of sticks six feet in diameter, which it either places in the fork of a tree or on a ledge of rock. The external model resembles that of the Wren, to select a familiar example, but the internal arrangements are very different. This globular stick-made nest is said to contain three divisions, each with so small an entrance that the bird gets through it with apparent difficulty. Of these chambers the top storey is the receptacle for the eggs, the middle one is a kind of play-room for the young birds when full grown, whilst the basement is used for lookout purposes by the old birds. Then we have the most extraordinary methods of nidification prevailing amongst the Mound Birds (Megapodiidæ). These birds, as we have already briefly stated, bury their eggs in sand or amongst fermenting vegetable matter, the heat from which eventually hatches them. Dr. Wallace, writing of this peculiar habit, informs us in his delightful

book on the Malay Archipelago that the Mound Bird inhabiting the Moluccas forms an immense mound of vegetable rubbish as much as eight feet high and thirty feet in diameter. This the birds throw up with apparent ease, grasping the material in their large feet and throwing it backwards. In the centre of the mound, at a depth of several feet, the eggs are laid, and eventually hatched by the heat generated by fermentation. After the eggs are once deposited in this curious incubator the parent birds appear to evince no further thought for them, and the newly-hatched chicks work their way up through the rotten rubbish and at once run off into the adjoining forests. The species that burrow in the sand appear to tunnel obliquely for about three feet, and then the eggs are laid at the end of the gallery. The entrance is then closed and the eggs left to hatch in due course. Another species peculiar to the Nicobars was found to make a mound eight feet high and sixty feet in circumference. Sometimes lizards lay their eggs in these mounds. The Australian Brush Turkeys (of various genera in the same family) have very similar habits, collecting enormous heaps of vegetation, sometimes consisting of many cartloads, and laying their eggs

in circles about a yard from the apex, where the generating heat hatches them. It is rather remarkable that one of the Coursers—the Cursorius ægyptius of ornithologists — resorts to similar methods of nidification, burying its eggs in the sandy banks of the Nile, where they are at least partially hatched by the sun. Incidentally we may also mention that not a few other and more familiar birds partially invoke similar aid ; for many of the shore birds —such as Gulls, Terns, and Plovers—rarely sit upon their eggs during the hottest hours of the day; whilst the Grebes and some of the Rails derive considerable assistance in the task of incubation from the fermentation of the aquatic vegetation with which they construct their often floating raft-like nests. It is possible that the dense bed of down which the Ducks and Geese, &c., provide for their eggs may materially assist in preventing loss of heat, especially in high latitudes, but that it also serves to conceal them during the parent's temporary absence seems to us unquestionable. Were it not for this precaution the very conspicuous eggs would soon fall a prey to marauding birds and animals. Another exceptionally curious type of nest is made by the Flamingoes.

These long-legged birds, as we have already seen, frequent marshes and lagoons. They build a most extraordinary nest, a tall conical pillar of mud, with a shallow cavity at the apex for the eggs. This structure is most beautifully adapted to the conditions of nidification, being either built in shallow water or so near to the margin and in swamps subject to more or less sudden inundation.

The thoughtful reader may well ask the meaning of all this wonderful architecture, the motive for such varying means for ensuring the safe maturity of the eggs. It is not, however, the protection of the eggs that is the sole consideration, the safety of the incubating parent is of no less importance—safety, be it remembered, at a time when the usual means for securing it are not so readily available, and various exceptional dangers have to be guarded against. To a very great extent (even to a degree that amounts practically to a Law) the colour of the parent's plumage is correlated with the manner of nidification. To understand the facts it will be necessary to divide birds into various classes quite irrespective of their taxonomic affinities, but according to the relation between the colours of their plumage and the methods of their nidification.

Before the reader of this volume has reached the present chapter he will be aware that in a great many species there is a most marked difference in the colour of the sexes, the females in such instances being very much less brilliantly coloured than the males, in not a few cases this difference being so marked that one sex is totally different from the other in general appearance. Now this dull colour in so many female birds is intimately connected with the special means of nidification, and we find in a vast number of species such inconspicuous tints are correlated with an open nest. This is admirably illustrated by such a species as a Pheasant or a Black Grouse. In both these species the males are very brilliantly coloured, their plumage being exceptionally beautiful and conspicuous, whilst the females are utterly different and dressed in tints of mottled browns and yellows. These birds nest on the ground, but they are careful to lay their eggs amongst vegetation where their own plumage harmonises so closely with surrounding tints that they are very difficult to see as they brood over their treasures. We find the same rule prevailing amongst hosts of other species which we have not space to describe in detail here.

But then, on the other hand, we have certain species in which there is not such a marked contrast in colour between the sexes, both being adorned with showy, conspicuous, or even brilliant coloured plumage, and which notwithstanding build open nests. This at first sight seems a fatal objection to any law; but we must remember that some of these colours are rendered inconspicuous by the special method of nidification, and that in other cases the nests are so hidden amongst foliage that the sitting parent is well concealed from view. Then, again, many of the species that come into this division do not need to derive their safety whilst incubating from an inconspicuous dress, because they are pugnacious or powerful and well able to defend themselves and their charge from attack. Among such birds we may name the gaudy Jays, the conspicuous Herons, Gulls, Crows, and so forth. Other and less combative species sit very lightly, and leave their nests the moment danger is detected. Then, again, we have to consider another small group in which the male is less showy than the female, yet still hatch their eggs in open nests. We have already alluded to this phenomenon, but not, however, from the present point of view.

Here we find that the males invariably perform the duties of incubation, and in some instances at least are known to display the greater solicitude for the eggs and young. The Dotterel and the Phalaropes are two of the most familiar instances.

We now come to consider the special mode of nidification in species where both sexes are of bright and conspicuous colours. Here, again, the reader will have many instances in mind. By far the greater number of species coming into this group are tropical forms, a very large number being included in the order Coraciiformes. The rule in this group is that bright plumage is correlated with a covered nest. The sitting bird either hides itself in a hole of a tree or rock, or in the ground, or builds a domed nest in which it can conceal itself. This will explain why we have found so many remotely allied species adopt the same methods of nidification. Some of these nests, however, are placed in very exposed situations where they would seem to invite attack. But as we have already shown in not a few instances, these nests are hung quite out of reach of enemies, over water and at the extremities of long slender branches. Then we must remember how

cunningly so many nests are concealed by harmonising their materials with surrounding tints. In this group, again, we have what appears to be a fatal exception, for there are not a few species in which both sexes are not only dull in colour, but build covered nests or place them in sites well concealed from the outer air. But in these cases we must assume some special advantage in other ways, such as greater warmth and shelter or protection from the sun or certain enemies. Many of the species are exceptionally weak and defenceless, such as the Swifts, Sand-Martins, Wrens, Willow Warblers, and so forth; whilst the pugnacious Owls seek seclusion because they are mostly nocturnal and dislike the light. What more natural than that they should rear their young in their day retreats? Lastly, we have a group in which the females are decidedly less showy than the males, and yet rear their young in covered or concealed nests. The Redstarts, some of the Flycatchers, the Chats, and Robin Chats, may be instanced. In some cases, however, the male assists the female in the duties of incubation; in others some special advantage or protection is doubtless secured.

We may fittingly conclude the present chapter

with a few remarks upon the mental powers of birds that are called into play for nest-building. Birds' nests have long been regarded as one of the most convincing proofs of blind instinct. Birds are popularly believed not only to be hatched with the power of singing the song peculiar to their species, but with an inherited knowledge of how to build their special type of nest, without tuition or experience. But such an assumption is not supported by one iota of fact or proof. On the other hand, all the evidence at present available tends to show that birds are not hatched with any instinctive power to make a nest, but that they have to acquire the art by imitating the work of others—the nest in which they were reared. To credit birds with this infallible nest-building instinct is to endow them with powers that man himself does not possess. Man with his marvellous development of reasoning power is as little able to build a dwelling typical of his race or tribe without instruction or experience as a bird is its nest. Neither is one creature more gifted than the other in the matter of language or song, for both have in each case to be learnt. Instinct, again, if it is anything it is unchangeable, and therefore if it controls

nest-building these structures should never show any variation from a certain type. But we know that this is not so, for birds not only change their materials but their mode and situation of nest-building. Many birds have done so within the measure of historical record. Swallows have changed their mode of nidification, and deserted rocks or caves in certain civilised countries for buildings; the House Sparrow and the Starling have done the same. Then we have instances of birds changing their mode of nesting to escape some threatened danger, as for instance the Moorhen building in trees, in spots liable to sudden floods, or certain Penguins forsaking exposed open sites for their nests and selecting covered situations to guard them against the depredations of pigs. Many other examples might be quoted to show, beyond all reasonable doubt, that birds are ever ready to take advantage of any favourable circumstances, and to alter their habits accordingly. The materials of nests are also constantly being changed, and instances are on record where the most unsuitable articles have been fabricated into receptacles for their eggs. It would be most unfair then to attribute to birds such a poor substitute for reason as blind

instinct. Rather should we endow them with limited reasoning powers, with intelligence and forethought, in the construction of their beautiful if utilitarian homes. It is almost safe to say that if birds had not been so endowed with some amount of reasoning faculties, enabling them to change their habits and economy in sympathy with a changing universe, they would all have become extinct long ago. One of the most remarkable proofs in favour of reason and absolutely fatal to instinct was brought before our notice years ago. Some young Chaffinches were taken out to New Zealand, and these in due course attempted to make a nest. The structure was so utterly different from the typical nest of this species as to be quite unrecognisable, and was possibly a crude imitation of the nest of some New Zealand bird. Particulars of this instance were fully recorded by us in *Nature* at the time, and again in our work entitled *Jottings about Birds*. It is somewhat difficult, however, to grasp the complete philosophy of this entrancing subject of nidification without taking into consideration the Eggs of birds, and to these we intend to devote the following chapter.

CHAPTER VIII

THEIR REPRODUCTION (EGGS)

Eggs—The development of the shell—The deposition of the colour pigments—The shape of the markings—How formed—The two types of markings—Their distribution—General resemblances amongst eggs of the same species—Exceptions—Composition of the colour pigments—The incubation of the egg—Incubation periods in the various avine orders—The incubating sex—The texture or grain of the egg-shell—The colour of the interior of the shell—The form of eggs—The size of eggs—The number of eggs produced by species in the various groups—The colours of eggs—Generic types of eggs—Variation in the colour of eggs in the same species—Of the Guillemot—Of the Cuckoo—Uniformity of colour in other groups—The colours of eggs hereditary—Eggs of hybrids—The ancestral colour of eggs—The utility of colour—White eggs in covered nests—In open nests—Spotted eggs in open nests—In covered nests—The protective colouration of newly hatched birds.

FOR centuries the Eggs of birds have attracted the attention of the scientific naturalist; and there can be little doubt that they have been the coveted spoil of the less learned perhaps from an even earlier period still. To most people their central attraction is their great beauty and

wonderful variety. But here we must look behind this beauty and variety, and seek their motive and utility—the part they play in the Story of the Birds. The study of nests and eggs is one of the most important branches of ornithology, for in the proper pursuit of it the observer cannot fail to become familiar with much of that detail which forms the all necessary supplement to those portions of the science which are covered by our earlier chapters.

We may pass over the strictly embryological portion of the study of Eggs, and commence our description at that point in their history when they receive their shell in the uterine chamber of the parent. Here, according to Dr. Gadow and other anatomists, the egg remains for twelve to twenty hours, receiving during that time its shell, which is formed by calcareous excretions of the glandular walls of the uterus. The external layer of the shell is most variable, and may be smooth and shiny, as in that of a Woodpecker, due to the small amount of calcine salts, or rough and chalky, as in that of a Cormorant, owing to an excessive amount of these. Then comes the deposition of the colour pigments, in such eggs that are spotted, this apparently always taking place shortly before

exclusion. As pointed out by Professor Newton, these markings are generally and normally deposited in a circular form—as *spots* of varying size—but in the passage of the egg through the oviduct many of them become blurred, protracted, and smeared in endless series of combinations, and then the egg is blotched, or receives that appearance with which every egg collector is so familiar. Many of these blotches or patches of colour are protracted in some particular direction, as the egg apparently passes on with a rotatory motion towards the vent. This explains the marked spiral deposition of the markings on many eggs. But the eggs of all birds, with the sole exception of those of the Game Birds, as we discovered long ago when working with the late Henry Seebohm, have two very distinct types of markings. If we examine an egg of a Guillemot, for instance, we shall find that amongst the richer spots and blotches there are others (varying in amount to a great extent on individual eggs) much paler in colour, due to a thin coating of shell material lying over them. These paler markings must be deposited at the earlier stage of the colouring process, and may be either circular or protracted into blotches and irregular stains. This may be proved by

taking an egg ot a Guillemot, say, and gently scraping the surface over one of these indistinct underlying markings, when it will gradually assume the same intensity of hue as the superimposed blotches or spots. The varying degree of intensity of these underlying spots depends, of course, upon the amount of shell deposit over them. In some eggs they are just below the surface; in others they are faint and indistinct, with a thick coating above them; whilst in not a few eggs we may find them both pale and distinct. In some eggs these markings predominate, but the rule seems to be for the surface spots to be most numerous. The circular spots must therefore, on the above supposition, be deposited when the egg is at rest; whilst the pigment must dry very rapidly, or we should not see that delicate tracery that is so characteristic of the eggs of Buntings and various other species. Generally speaking, the markings are most abundant on and towards the blunt pole, or larger end of the egg, which, we should say, is always protruded first. This position, however, is sometimes accidentally reversed, as seems proved by the fact that occasionally the colouring matter is almost entirely collected upon the smaller end of the

egg. In some groups this is much more frequent than in others, as, for instance, amongst the Birds of Prey and Terns and Gulls. The ground-colour in the eggs of such species that display it appears to be deposited soon after the first set of spots are distributed; in Game Birds the deposition of spots and ground-colour may be almost simultaneous. The amount of colouring matter deposited is remarkably uniform in the various species, generally speaking, especially as regards the ground tint. Its arrangement, however, is so diverse that probably no two eggs are exactly alike, although they present certain characteristics that render identification a fairly easy task. As a rule, the eggs in a clutch resemble each other; and in many cases we know that this resemblance keeps constant through successive clutches laid by the same parent; possibly the similarity may exist permanently during the life of the producer. Most collectors have had experience of this fact, obtaining certain peculiarly marked eggs from certain spots for several seasons in succession. This extends not only to eggs of the normal colour, but to others displaying certain peculiarities of markings, or even the want of them. In some species it is almost an invariable rule

to find one egg in the clutch differing considerably from the rest. In some of the Birds of Prey this peculiarity is very striking, and in no species more so perhaps than in certain Eagles and Vultures. In the Golden Eagle, for instance, one of the two eggs is generally much more heavily spotted than the other. This is often attributed by collectors to the fact that the colour pigments were all exhausted in decorating one egg only; but it has been proved many times that the first egg has been the one in which markings were wanting. It may be that the colour-producing glands had not sufficiently recovered their functions peculiar to the laying season before the first egg was deposited. We have sometimes remarked a similar peculiarity in the eggs of various Passeres, the *first* egg laid being much less handsomely marked than those that succeeded it.

For the exact composition of the colour pigments on eggs we are indebted to the researches of Dr. Sorby, who ascertained by the aid of spectrum-analysis that no less than seven substances were found in them. These were named Oorhodeine, Oocyan, Banded Oocyan, Yellow Ooxanthine, Rufous Ooxanthine,

Lichenoxanthine, and lastly, an as yet unnamed substance yielding narrow absorption-bands in the red. These colours appear to be closely associated with bile-pigments, although not actually agreeing with them. Oorhodeine is present in most eggs, its absence being exceptional, and is brownish-red in colour; Oocyan and Banded Oocyan are, as their names suggest, blue; Yellow Ooxanthine and Rufous Ooxanthine furnish yellow or reddish-yellow, the former when mixed with Oocyan producing a beautiful dark green; Lichenoxanthine is believed by Dr. Sorby to be a constituent of the shell of eggs of a brick-red colour. The undetermined substance is believed in combination with others to produce an exceptionally brown tint. Oorhodeine is believed to be closely related to Cruentine, and possibly derived from the red colouring pigments of the blood, and further, that the two Oocyans have some chemical relation with the bile. The reader anxious to go deeper into this interesting question may be referred to Dr. Sorby's paper on the subject published in the *Proceedings of the Zoological Society of London*, 1875 (pp. 351–365). Whether Dr. Sorby's very interesting lecture upon the subject of the colouring matter of

birds' eggs, and which we had the pleasure of hearing in Sheffield a quarter of a century ago, is published we are unable to say.

When the egg-shell is completed, and in the case of spotted or coloured eggs the pigments have been deposited, the egg makes its way from the cloaca out through the vent. It now awaits incubation, or the development of the contained embryo, in a nest or not as the case may be, after which process the perfect chick is duly hatched. The time occupied in this process varies considerably in the different groups. It has been observed that the length of this incubation period depends not only upon the state of perfection in which the chick leaves the egg, but upon the size of the parent (the larger species taking a greater number of days than the smaller ones[1]) and the prevailing temperature of the area or country in which it takes place. It has been ascertained that a reduction of temperature will temporarily arrest the development of the embryo in its earliest stages, whilst a higher temperature than the normal one will not

[1] Size alone is not a determining factor. We must also take into consideration the order or family to which the species belongs as well as the relative size.

lessen the period of incubation, but often prove detrimental to the life of the embryo. According to the observations of Mr. Evans (*Ibis*, 1891, pp. 52–93), and the many facts relating to incubation collected by him, the smaller Passeres hatch their eggs in from twelve to fifteen days, the larger species, including the Raven, in nineteen or twenty days. The Crow family are apparently the longest incubators in the order, as of course they are the largest species. In the Coraciiformes the period may be slightly longer, but some of the Humming-Birds are said to hatch their eggs in ten or twelve days, whilst the Rollers, Kingfishers, and Woodpeckers take from eighteen to twenty. In the Owls the period of incubation is a long one, ranging from twenty-six days in the Long-eared Owl to thirty-three in the Eagle and Snowy Owls. The Birds of Prey in some cases are known to occupy from four (in the Kestrel) to five weeks (in the Eagle). The Condor is said, however, to take fifty-four days. The Gannet takes nearly six weeks; the Cormorant about a month. The Herons vary from about seventeen days in the smallest species to twenty-five days in the larger, whilst the Stork is said to occupy thirty days. Among

the Ducks we have a range of from about twenty days in the smaller species to thirty days in the Geese, and from thirty-five to forty days in the Swans. The Typical Pigeons range from about fifteen to seventeen days, the largest species in the order a month. The Sand-Grouse incubate in a little over three weeks to a month. In the Galliformes the smaller species like the Quail take about three weeks, the larger species a month. This is also about the limit in the Charadriiformes and the Lariformes. The Petrels are longer, the smaller species taking about five weeks; the larger, such as the Albatrosses, eight or nine weeks. The Auks take more than a month (thirty to thirty-five days); some of the Impennes are said to occupy six weeks, whilst the Emu requires a couple of months, the Rhea two weeks less, and the Ostrich takes from seven to eight weeks, or even more. In some species incubation commences as soon as the first egg is laid; in the majority of cases, however, the process does not begin until the last egg of the clutch or sitting is deposited. As we have already seen the female in most cases is the principal incubator; in some instances both sexes incubate in turn;

whilst in a very small number the cock bird alone performs the duty. We may also state that amongst the wading birds the chicks remain in the shell for some little time after it is cracked for their egress.

But to return more particularly to the consideration of the egg-shell. The texture, grain, or surface of this requires a short notice. This varies a good deal, and to some considerable extent the peculiarities of its surface are characteristic of certain groups. In a great many species the grain of the shell is so minute that the surface of the egg is more or less highly polished, as in the case of the Woodpeckers, reaching its greatest smoothness in the curious eggs of the Tinamous. In the majority of species the shell is comparatively smooth, although in many a very minute grain is visible even to the naked eye. In others it is dull, somewhat rough and lustreless, as in the Guillemot or the Sparrow-hawk, for instance. In others yet again the surface is covered with minute pits or pores, or grooves like shagreen, reaching their highest development in such Ratitæ birds as the Ostrich and the Emu. Then the egg-shell of various aquatic birds, especially the Ducks, is peculiarly wax-like or

oleaginous, whilst in the opposite direction we have the rough-textured eggs of the Grebes and the Cormorants, Gannets, and so forth, the shell of which is coated with chalk, often so thickly as entirely to obliterate the delicate pea-green of the ground colour. The colour of the interior of the shell when held up to the light also presents some diversity, even in obviously very closely allied species. In the Guillemot, for instance, the interior of the shell always appears yellowish-white if held up to the light and viewed through the hole from which the contents have been removed. In the Razorbill, however, the interior of the shell when examined in the same manner is a delicate pea-green. This fact always serves to distinguish between the eggs of the two species, even when they closely resemble each other in colour.

Eggs vary in form almost as much as they do in colour. We do not intend this remark to apply in a strictly individual sense, although considerable variation is apparent in the same species, but chiefly to the various great orders and families. Broadly speaking we can divide their form into three fairly distinct classes or groups, but almost every intermediate shape

connects the extreme type. These are Round, Oval, and Pyriform. Round-shaped eggs are a special feature in such groups as the Falcons, Owls, Woodpeckers, Rollers, Kingfishers, Bee-Eaters, and so forth. Oval eggs are specially typical of the Sand-Grouse, Pigeons, Nightjars, and Cormorants, but various modifications of this form are common to the majority of birds, from the biconical shape characteristic of the Grebes to the more familiar form of those of the Song Thrush and most Passerine species, as well as in the Game Birds, Petrels, and many others. Pyriform eggs are chiefly confined to the Charadriiformes, such as the Plovers, Snipes, and Sandpipers, but also occur in the Auks and one or two other families. We are as yet unable to say definitely why the eggs of birds assume these various shapes, but certain hypotheses have been put forward to account for them. One of the most ingenious and attractive of these is that of Dr. Nicolsky. This naturalist asserts that the normal shape of an egg is spherical, and that it becomes more or less elongated by pressure from the walls of the ovary before the shell is deposited. He makes the suggestion that birds laying spherical eggs usually maintain an upright position, in which the weight of the egg

counteracts the pressure of the ovary; whilst birds which lay oval eggs maintain a horizontal attitude, the weight of the egg then assisting the pressure of the ovary; and lastly, birds which lay pyriform eggs frequently change their position from a vertical one when standing to a horizontal one when flying or swimming. Seebohm, on the other hand, has suggested a possible correlation between the state in which the young are hatched with the shape of the egg, the long-legged præcoces laying pyriform eggs and the short-legged altrices laying round eggs, whilst the long-legged altrices and the short-legged præcoces produce oval eggs. The subject requires much more elaborate investigation than it has hitherto received before any conclusion can be drawn.

Now a few words concerning the size of eggs. Here again we do not mean the variation in this respect amongst the eggs of a single species or individual (although this is much greater than is generally suspected), but more the proportionate size in relation to the parent in the several orders and families. A big bird by no means always lays a big egg, neither does a small bird always lay a small one. In some species this disproportion between the egg and its parent is very

remarkable. A Jack Snipe, for instance, a bird not much bigger than a Sparrow, lays an egg considerably larger than that of a Magpie, and not much inferior to that of a Crow. A Guillemot's egg is as large as that of the Golden Eagle, the average actual measurements of the former being 3.3 inches by 2.0 inches, whilst those of the latter are 2.9 inches by 2.3 inches. Whether the number of eggs to be covered by the parent during incubation determines the size, or whether the state of the young when hatched (the largest eggs relative to the size of the mother producing the most precocious chicks) be the influencing factor, we are as yet unable to say. Possibly both facts may exert some influence. The connection between relative size, shape, and number appears certainly to be an intimate one. There is considerable diversity in the number of eggs produced for a clutch or sitting. Species, for instance, like the Gannet, the Guillemot, the Petrels, the Puffin, and the Tropic Bird lay one egg only for a sitting; Pigeons, Eagles, Vultures, Goatsuckers, Humming-Birds as regularly produce two for the same purpose; Gulls and Sand-Grouse three; whilst the Sandpipers, Snipes, and many Plovers as regularly lay four. Most of the Passeriformes

lay on an average five or six; some of the Coraciiformes, such as the Kingfisher, and some Woodpeckers, lay six or eight; whilst amongst the most numerous egg-producers we must include the Game Birds, some of the Rails and the Ducks, their clutches varying, roughly speaking, from ten to twenty or even more. The number of eggs that a bird may lay is no indication of its relative abundance. The Fulmar was computed by Darwin to be the most numerous bird in the world, and yet it lays but a single egg. The Gannet, the Guillemot, and the Puffin exist in countless hordes in northern latitudes, yet all of them lay one egg only. On the other hand, species that produce an exceptional number of eggs are not proportionately numerous. A possible explanation of the phenomenon may be that the species producing the fewest eggs are least exposed to decimating influences, whilst those that lay an exceptionally large number may be more liable to the attacks of certain enemies.

The colours of eggs are to a certain extent characteristic of the various orders, families, and even genera, which, on the theory of evolution, is only what we might expect to find. As a rule the more closely allied the species the greater will

be the similarity of the eggs. But that this is not always the case is proved by such great divergencies as are presented in the eggs of the Song Thrush and the Redwing, the Swallow and the Martin, the Goshawk and the Sparrow-hawk, the Little Bittern and the Common Bittern, and so forth. On the other hand the peculiar characteristics of the eggs in such groups as the Crows, the Sandpipers and Snipes, the Birds of Prey, the Pigeons, the Owls, the Petrels, and Tinamous, are so sufficiently pronounced that any experienced collector can readily distinguish them at a glance. The eggs in the various genera of Warblers are most significantly characteristic and readily assignable. In the Willow Warblers we have white eggs spotted with red; in the Tree Warblers the eggs are salmon coloured, spotted with brown; in the Grasshopper Warblers the finely powdered markings of brown, and their general pinky appearance, readily serve to distinguish them; in the Reed Warblers greens and olive browns are the predominant colours.

We have, however, much variation in some cases even in the same species. What, for instance, could be more astonishing in this direction than the extraordinary variety in the eggs

of the Common Guillemot. A judiciously selected collection of these eggs justly forms one of the most wonderful attractions of the oological cabinet. In no other known species does the egg vary so widely. The ground colours are dark green, yellowish green, reddish brown, cream yellow, white, and pale blue, with every intermediate shade; the markings are browns, and greys and pinks of every possible tint, and take the form of spots, splashes, blotches, streaks, zones, and intricate netted tracery. Then we have certain species in which the individuals produce distinct types; as in the Grass Warbler (Cisticola cursitaus), the eggs being either white or blue spotted with rufous, and sometimes unspotted blue or white. The Common Cuckoo is also known to produce several very distinct types of eggs, one being unspotted blue. The uniformity of colour in other groups is just as remarkable. The Herons are always some shade of blue or green; the Game Birds, although differing considerably in general colouration, may always be distinguished by the entire absence of underlying markings; the Pigeons are always white or the palest of cream colour; the Parrots are white; the Birds of Prey are marked with reddish brown only; most of the species in the

order Coraciiformes are white. Taken as a group the Passeriformes present us with the greatest diversity of egg colouration, possibly owing to their high degree of specialisation and the vast variety of conditions under which they live. As a general rule their eggs are more or less spotted, white or blue eggs being exceptional, although characteristic of such families as the Sturnidæ, the Dicæidæ, and the Cinclidæ. How far the colours of an egg are hereditary we are as yet unable to say. We do know, however, that certain individuals produce certain varieties, and appear to continue to produce them as long as fecundity may last. To what degree the parent transmits certain peculiarities in its own eggs to those produced by its offspring is, however, unknown, although there is some slight evidence to suggest a hereditary tendency. Of course, broadly speaking, in this, as in so many other things in nature, "like produces like," and we know that the eggs of birds continue to exhibit certain general characteristics from generation to generation. Another branch of this subject relates to hybridisation. It has been alleged that the egg containing an hybrid is not exactly similar to that produced by the female, but resembles to a greater or lesser extent the eggs of

the species to which the male may belong. Here again, however, we are in the dark, and the subject is one fraught with interest, and its study is likely to yield results of great value.

We have now to consider the more philosophical portion of the subject of eggs. Here, as we found to be the case with nests, the wondrous beauty of these shells is purely a utilitarian one, and it behoves us then to inquire what part these varied tints play in avine economy. As we found that to a very great extent the colour of the parent's plumage is correlated with the manner of nidification and the style of architecture, so in like manner shall we find a similar relationship between the colour of the eggs and the manner in which they are brought to maturity. Here again, in order to understand the facts, it will be necessary to divide eggs into groups quite irrespective of the taxonomic affinities of the species that produce them, but according to whether they are adorned with colour pigments or not.

Taking into consideration the important fact that Birds and Reptiles have descended from some common ancestral type, we are probably correct in the assumption that the eggs of the earliest avine forms were devoid of any of those

colour pigments that adorn those of so many species at the present time. Colour appears to be an after development, purely for protective purposes, and in cases where it is not necessary we do not find it present, or it may be in such cases where we do so it is due to affinity or to hereditary causes. Or it may be the inability to develop it confines many species to certain methods of nidification. Now in a great many instances—in fact so numerous are these that we may lay it down as a rule—where the eggs are hidden from view in holes in the ground or trees, or in domed or covered nests, they are generally white or pale blue and without markings. Among such species we have the Woodpeckers, Kingfishers, Parrots, most of the Owls, the Rollers, Bee-Eaters, Dippers, Wrens, Titmice, and so forth. In all these cases the white eggs (or in some instances very sparsely spotted ones) would not only be very conspicuous if they were laid in open cup-shaped nests, but in not a few species the sitting bird itself would be rendered equally conspicuous by its brilliant or showy plumage. But then it may be urged that there are, on the other hand, a very considerable number of species which actually do lay white eggs in open and exposed nests. These apparent

exceptions, however, only tend to prove the truth of the rule. We have Ducks, for instance, also certain Game Birds, Grebes, Rails, some Owls, Pigeons, Nightjars, Herons, Cormorants, and Storks, in all of which the eggs are very conspicuous, and yet they are laid in open nests. Now as regards the Ducks, certain Game Birds, Grebes, and some Rails, we find that not only is the parent's plumage very protective in colouration, thus shielding the conspicuous eggs from view, but when the nest is left the hen bird is very careful to cover the eggs with leaves and other materials that effectually hide their showy tints from view. That this seems certain is proved in the case of the Ducks. Those species with down of neutral and dull shades of colour use it to conceal their eggs during absence from the nest, but other species in which the down is very light coloured—as for instance the Golden-Eye, the Goosander and the Smew—resort to holes in trees in which both the conspicuous down and the conspicuous eggs are hidden from sight. Then again, the hen Partridge and the hen Pheasant, for example, lay their unmarked eggs in open nests, but when they are sitting upon them their own plumage is a most effectual protection, whilst when they leave their

charge for a brief interval they are careful to strew leaves and withered herbage over them. So also does the Little Grebe, for example, the rapidity with which it can cover up its eggs when leaving them in a hurry being simply marvellous! The Short-eared Owl lays her white eggs on the open fens and marshes, but she carefully shields them from view by her own inconspicuous brown dress, and is a most persistent sitter, only leaving her charge when absolutely compelled. The Pigeons again all lay white eggs, and the majority of species incubate them in flat open nests. Here again, these nests are not only very inconspicuous, but generally placed amongst dense foliage—ivy in particular—and the birds themselves are excessively wary during the period of incubation. Then we must remember that Pigeons are not only an abundant but very widely dispersed group, especially in islands, where enemies are few or absent, and these facts surely indicate an immunity from danger or special means of eluding it. The larger birds, such as the Herons, Cormorants, and Storks, which lay unspotted eggs in big flat open nests, are equally safe from all ordinary enemies, for they are quite strong enough to protect their eggs from danger, and often breed in societies,

where the entire community will join in repelling any attack made by predaceous bird or beast upon their eggs.

We now come to that division which includes the marked or spotted eggs, which, as a similar rule, are generally deposited in open nests or upon the bare ground with no auxiliary protection whatever. In this group we begin to realise the true significance of colour. The colour of the egg, in a very large number of instances, so closely resembles the ground on which it rests that its discovery is only effected by the most careful scrutiny. Every egg collector must have experienced the difficulty of finding such eggs as those of the Lapwing, the Ringed Plover, or the Lesser Tern, to quote but three instances out of quite as many hundreds. The one bird lays its eggs, often bare and nestless, upon the rough fallows and waste ground of the uplands, where their yellow ground colour and brownish-black markings most effectually hide them from detection. The others, Ringed Plover and Lesser Tern, deposit their eggs on the sea-shore, also providing no nest. The former species, however, always selects a strip of fine sand, where the minutely speckled eggs closely resemble it; whilst the latter bird as

surely chooses a patch of rougher shingle, where its more heavily-marked eggs so closely harmonise with surrounding objects that we may tramp to and fro across its breeding-place in vain quest of objects we know are there. And so we might go on giving instance after instance of richly-marked eggs deriving their sole safety from enemies from the resemblance between them and surrounding objects. Then again, we also find that birds building open nests amongst foliage lay eggs more or less green in tint, as in the Crows, Thrushes, Warblers, and so on. Many of the smaller birds, as we have already seen in the previous chapter, take great pains to conceal their nests by building them externally of materials very similar in colour to objects surrounding them; in the majority of cases the eggs themselves are also of quiet colours, or in those species where they are more conspicuous, the dark thickets and shrubs are selected, where they are seen with difficulty.

Here again, the objection may be similarly urged, that as we found white or unspotted eggs in open nests, so also conversely do we find many instances of spotted eggs deposited in covered nests. We have, for instance, the Jackdaw laying its spotted eggs in nests well

shielded from the light of day, the Chough hiding them in holes of rocks, the Grass Warbler concealing its highly-spotted eggs in a singular purse-like nest, the Nuthatches and some of the Tits laying in holes in trees, and so forth. The most plausible explanation of these anomalies is that in some cases the mode of nesting has undergone a change within comparatively recent time; and certainly this is borne out by the fact that, in such instances, the eggs are very perceptibly paler and less heavily marked than those of congeneric species breeding in open and exposed nests. Oologists know that the eggs of the Jackdaw and the Chough are very much less marked than those of the Crow or the Jay. We know that it is a pretty constant rule in nature, that when once any special development ceases to be functional it has a very strong tendency to disappear. In the case of domed nests we may almost safely assume that this particular style of architecture is a recent adoption, and the spotted eggs have not yet lost their character. Then again, we must remember that the colours of eggs are to a great extent common to groups, orders, or genera, as the case may be; and then we can understand why we might find a spotted egg in

a covered nest, the parent having for a variety of reasons changed its mode of nesting from that usually adopted by the group to which it belongs. In not a few of these cases it is by no means unusual to find an egg quite devoid of pigments—as in the Grass Warbler, for example—and we can thus understand how in the course of time such a type might come to prevail, the tendency of the colour-producing glands to become functionless through want of use or demand. We must also bear in mind another common fact in nature, namely, that many contrivances are retained long after their direct use has ceased, because they may be in no way injurious to the species. But these are questions quite outside the scope of the present volume, fascinating enough, but demanding more scientific treatment than is here possible or desirable. We ought, however, in bringing the present section of our subject relating to the Reproduction of Birds to a close, to devote a few lines to the protective colouration of many newly-hatched chicks. In a great many cases the chick that has been brought to maturity within a shell decked with protective hues, walks into the world clothed in a dress of similarly protective design, and, what is more remarkable,

with a marvellously rapid developed aptitude for deriving the fullest advantage from it. The young of all birds hatched in a condition which enables them to run, are clothed in down of such colours that harmonise closely with the special localities in which they live during infancy. Then these chicks soon acquire the habit of squatting close to the ground when threatened by danger, and thus ensure the efficacy of their protective dress. Caliology, the study of nests, and Oology, the study of eggs, although as yet but little-worked branches of ornithology, must, however, always be classed as not the least interesting portion of the Story of the Birds.

THE END

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